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NOTICE TO AUTHORS OF PAPERS

1. Forwarding Address. Papers intended for publication in THIS JOURNAL should be submitted to Neil E. Gordon, Editor, The Johns Hopkins University, Baltimore, Maryland.

2. Manuscript. The manuscript submitted should be an original (not a carbon) copy, and typewritten, double-spaced, with 2–3 cm. margins. The title of the article should be followed by the name and address of the author. If the paper has been presented at a meeting, a footnote giving name of society, date, and occasion should immediately follow the author's name. The usual editorial customs, as exemplified in the most recent issues of the JOURNAL, should be followed as closely as possible.

3. References and Footnotes. Each reference to the literature and each footnote should be inserted without a number, as a separate line (or lines) immediately following the word to which it refers in the text. A reference to literature should include, in the order named, the title of book or article, author's name, edition or volume, pages, date of publication, and, in the case of books, publisher's name.

4. Illustrations. Not all articles lend themselves to illustrations, but articles which do should be accompanied by as many pertinent illustrations as possible. As a rule, apparatus, particularly if complicated, is best presented by means of line or working drawings. Photographs are sometimes sufficient, however. When both can be obtained, it is generally desirable to include both.

Photographs should have a gloss finish and should be at least post-card size—larger, if possible. Only prints which are unblurred and which show sharp contrast between light and dark areas can be satisfactorily reproduced.

Line drawings should be carefully prepared in black ink on plain white drawing paper or blue drawing cloth, twice or three times the size desired in the printed cut; it is convenient, when permitted by the scale required, to have them the size of the manuscript. When coördinate paper is used, it should be printed in blue only, with the important coördinate lines ruled over in black; the black square should in general not be less than ten millimeters on a side; the lines of the curves should be the heaviest, except the frame; points on the curves should be indicated by true circles, not crosses. The numbering of the coördinate axes, the number of the figure and any necessary explanations of the figure should be written in pencil in the margin of the sheet, as they are usually set up in type rather than reproduced from the drawing. All lines, numbers, and letters that are to be reproduced are to be so proportioned that they will be clearly legible in the cut.

Tables should be inserted in the body of the manuscript at the proper place.

All photographs, line drawings, and tables should be provided with self-explanatory titles or legends. Each illustration should be marked in pencil on the margin with the name of the author and the title of the article to which it refers.

FOTOGRAV. GEM. STAB. LIT. ANST.

Eduard Tessnar.

EDITOR'S OUTLOOK

Eduard Buchner, 1860–1917

EDUARD BUCHNER, whose contributions to organic and biochemistry were of such distinction as to win the Nobel award, was one of those whom the circumstances of early life yield but grudgingly to a destiny of greatness. Born in Munich, May 20, 1860, the son of a physician and professor of medicine, the boy was left fatherless at the age of twelve and faced the prospect of earning a livelihood without further education. This threatened calamity to Eduard Buchner and to science was averted by the influence of an elder brother, Hans, who was himself to acquire no small measure of prominence as a bacteriologist. Eduard was therefore enabled to continue at school and to complete his *Realgymnasium* training in 1877. His career as a university student, which centered in Munich and Erlangen, was interrupted for a time by work in a preserving factory. If the financial difficulties that pursued his student days were responsible for this, they proved a blessing in disguise, for it was this work that first awakened his interest in fermentation, the field which was to be the background of his most notable achievements.

Returning to his university studies, within the first decade of Baeyer's regeneration of the Munich school of practical chemistry, he took up experimental work in this field, and in the institute of von Nageli, he turned his attention to botany. It was at this time that Hans Buchner had the gratification of presiding over Eduard's early investigations, from which issued the younger brother's first publication, "On the Influence of Acid on Fermentation."

After securing his doctorate in 1888, he became a teaching assistant in Baeyer's laboratory and a *Privatdozent* at the university. With Baeyer's permission, he opened a small laboratory for experimenting on the chemistry of fermentation and began his investigation of the rupture of yeast cells. His ardor, however, was temporarily dampened by the director, who looked darkly upon time spent in a field which, as reflected in the literature of forty years, had so stubbornly resisted investigation.

In 1893 Buchner succeeded his friend and professional associate Curtius as head of the analytical department at Kiel and in 1896 he followed in the footsteps of another Munich colleague, H. von Pechmann, as special lecturer on analytical and pharmaceutical chemistry at Tübingen. Spending his autumn holidays of that year in the Hygienic Institute at Munich, of which his watchful mentor Hans was now director, he turned once more to his investigation of the cell content of yeast and in the following winter published his first work on "Alcoholic Fermentation without Yeast Cells."

In 1898 he was made regular professor at the Agricultural College in

Berlin. Serving at the same time as *Privatdozent* at the University of that city, he proved his abilities as a teacher by attracting an interested circle of students to his lectures and of assistants to his research. During the eleven years he spent in Berlin, he made new and agreeable contacts in his profession, sharing in the executive work of the German Chemical Society, of which he was president in 1904. The scope of his research continued to expand, his earlier organic experimentation with carbocyclic and heterocyclic compounds proceeding to scarcely less remarkable and valuable conclusions than the work which was crowned in 1907 by the Nobel Prize, awarded him "in recognition of his chemico-biological investigations and his discovery of cell-less fermentation."

His life at Berlin was profitable and happy, but he was not content with it. He aspired to the wider outlook of a university professor and accepted an appointment as such at Breslau in 1909, only to leave it two years later for a similar position at Wurzburg. Thereafter, we have the pleasant picture, sketched by a contemporary, of the investigator serenely pursuing studies of recognized scientific worth; of the teacher lighting new fires in the minds of his students and thus assuring the perpetuation of his work; of the Bavarian happily returned to his native hills and joyously detaching himself from his vocation in summer holidays to perform difficult feats of mountain-climbing in company with the associates of his youth; of the husband and father, absorbed in the interests of a lately established family, and making his home the center of a circle of friends who knew how to appreciate the warmth and vibrance of a personality whose peculiar charm was not patent to the many, but once known, was better worth the knowing.

Upon this pleasant scene broke the call of war. Buchner responded and as early as August 13, 1914, had assumed military duty as captain of a munitions column. Within the ensuing eighteen months, he saw service in France, East Prussia, and Poland, was awarded the Iron Cross, and promoted to the rank of major. In 1916, he laid aside his uniform to resume his professorial duties at Wurzburg, but when, in the spring of the following year, the entrance of the United States into the war put a new face on the conflict, he again surrendered himself willingly to the defense of his country. The head of a company which carried munitions to the troops on the Rumanian front, on August 11, 1917, he was struck by a flying fragment, dying two days later at Fochsani, where he was buried. Thus, in his fifty-eighth year, he made the futile sacrifice of a life that bore the promise of many years of ripe and fruitful scholarship.

To Mr. Sederholm, managing director of Nobelstiftelsen, Stockholm, Sweden, the JOURNAL *acknowledges its indebtedness for the accompanying photograph of Eduard Buchner.*

The Chemistry Leaflet

ONE important item of business transacted at the recent meeting of the American Chemical Society has resulted in the addition of a new member to the group of official publications sponsored by the Society. With the forthcoming number (October 24) *The Chemistry Leaflet* becomes an organ of the Division of Chemical Education and a supplement to the JOURNAL OF CHEMICAL EDUCATION. Its business management is accordingly transferred to the Chemical Foundation, with Mr. Wm. W. Buffum as business manager.

For the information of those who have not yet made the acquaintance of this excellent little publication, be it said that the *Leaflet* has behind it a two-year record of usefulness to teachers and students of elementary chemistry. During that period it has been edited, managed, and distributed by Mrs. Pauline Beery Mack of the Pennsylvania State College, in such spare time as remained to her after the demands of a full teaching schedule were met, and with the assistance of such student labor as she could afford to employ. Mrs. Mack, as an Associate Editor of the Division, still retains the editorial duties, but the onerous burdens of financial responsibility, business management, mailing, etc., have been lifted from her shoulders.

The *Leaflet* has been, and will continue, "a publication devoted to the popularization of elementary chemistry, written from the student's point of view." It follows the textbook presentation; hence, its contents are always timely and relevant to the classroom work. It seems to us that here the teacher of elementary chemistry has, ready to hand, a most effective tool. No student whose chemistry course is supplemented by the weekly reading of this little periodical can possibly retain the impression that chemistry is a dead and formal subject, without much relation to his every-day life or to the development of contemporary civilization.

Incidentally, *The Chemistry Leaflet* will be enlarged and adorned with a new cover. Further announcement will be found in the advertising pages of this number.

We are happy to welcome Mrs. Mack to the editorial staff of the Division and to offer her such encouragement and assistance as we may be able to furnish.

The Hopkins Experiment

AS THIS copy goes to press, the stage is set for the ceremonies which will dedicate the newly founded Francis P. Garvan Chair of Chemical Education at The Johns Hopkins University, and which will formally inaugurate the new and, we hope, significant experiment in chemical education which is being undertaken in connection therewith. Barring unforeseen contingencies, the

dedication program will be as published on page 2064 of our Local Activities columns.

We have previously discussed the Hopkins experiment in these pages—both editorially and otherwise. If further comment seems redundant, we can but submit in extenuation that the project is one which engages the editor's interest and enthusiasm to an unusual degree. Moreover, even when viewed with as cool and critical an eye as we can bring to bear upon it, the experiment seems to us to be one of more than passing importance and, hence, one worthy of more than brief and casual mention.

This feeling of optimism which prevails at The Johns Hopkins University and among the numerous friends of the institution who are contributing their moral and material support, as well as their counsel, is not based upon any deluded notion that the educational equivalent of the mythical philosopher's stone has at last been discovered. The experiment merely puts into actual operation a few of the ideas which seem to be eminently sound from a common-sense standpoint and which are almost universally endorsed but too seldom concretely applied. The unique feature of the situation is that careful planning on the part of the university officials and generous coöperation from public-spirited individuals and organizations have made it possible to remove many of the practical difficulties which so often make desirable procedure "impossible."

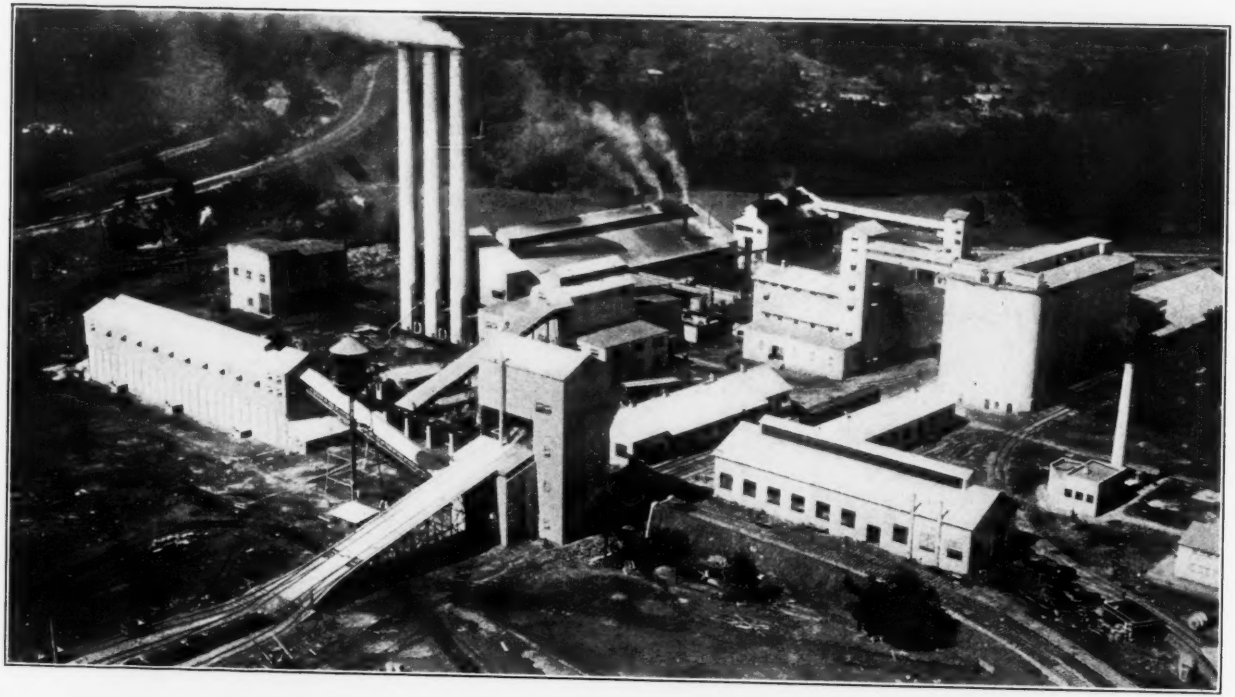
We all concede that the average course, geared to the mental capacity of the mediocre student, is inadequate for the full development of the exceptional student, even with what special attention we can give him in odd moments. Probably every instructor has, at some time or another, indulged in pipe dreams in which he has pictured the desirability of being able to plan for, and work with, a group of students who would be the equals in intelligence, in interest, and in serious purpose, of the best members of his present classes. But try to get such a group! That is exactly what The Johns Hopkins University *is* trying to do—first, by a careful process of selection, and, second, by assuring that the selected students shall not be hindered by the pressure of financial necessity. With such a group a system of instruction which lays emphasis upon initiative and independent effort on the part of the student seems more practicable than with a group, two-thirds of whose members grade approximately zero in independence and initiative.

It is unfortunate that certain editorial and news-item writers have made rather indiscriminate use of the terms "genius," "super-chemist," etc., in this connection. Such fauna may exist, but Hopkins does not maintain that they can be either selected in the rough or manufactured to order. The present scheme is considerably less high-flown and visionary—which is to say that sane men can discover in it some excuse for optimism.

THE DIALYZER

1. When, where, and by whom was the first so-called portland cement made? (p. 1855).
2. Why was the name "portland cement" adopted? (p. 1857).
3. Who produced the first portland cement of American manufacture? When? Where? (p. 1859).
4. How is portland cement defined? (p. 1861).
5. What two great chemists of the nineteenth century were born in Darmstadt? How has that city honored their memory? (p. 1869).
6. Who is the painter of the well-known portrait of Liebig? (p. 1871).
7. Who was Kekulé's first pupil? (p. 1880).
8. Will an empty vessel hold more air or water than a similar vessel filled with ashes? (p. 1882).
9. What are the essentials of a modern chemical lecture hall and preparation room? (p. 1887).
10. How may the subject of oxidation-reduction be presented logically? (p. 1894).
11. What are some demonstration experiments suitable for high-school chemistry classes? (p. 1905).
12. Are demonstration experiments of value in teaching analytical chemistry? (p. 1910).
13. Who extensively studied the "Warming and Ventilating of the Capitol?" When? (p. 1919).
14. What information can you contribute on the subject of tornadoes? (p. 1926).
15. How can a lecture lantern be adapted for the production of photographic enlargements? (p. 1928).
16. How can laboratory instruction in general inorganic chemistry be made more effective? (p. 1933).
17. Are radical changes in our educational system being made without sufficient proof of their justification? (p. 1940).
18. What place has qualitative analysis in the introductory chemistry course? (p. 1949, p. 1953).
19. A mixture of calcium oxide and strontium oxide weighed 0.3200 gram. When evaporated with sulfuric acid and weighed again as sulfates, the weight was found to be 0.6511 gram. Find the percentage of each oxide in the original mixture.

    In how few steps can you solve this problem? (p. 1980).
20. How can difficulties in getting students to visualize formulas of optically active compounds be overcome with the aid of inexpensive and readily available materials? (p. 1984).
21. What elections were made at the recent meeting at Minneapolis of the Division of Chemical Education? (p. 1994).
22. Has the Constitution of the Division of Chemical Education of the American Chemical Society been recently revised? (p. 1995).
23. What properties of gelatin make it suitable for the preparation of photographic films? (p. 2006).
24. What substance has recently been used in a new-type blowpipe to give a more intense flame than the familiar hydrogen or acetylene gases? (p. 2021).
25. Who invented the incandescent gas mantle? (p. 2051).
26. Are accredited higher institutions of learning in the U. S. listed by any organization? (p. 2055).
27. Can aluminum be obtained from alundite? (p. 2061).
28. And where is "Bohrville?" (p. 2065).
29. Are you making chemistry real, vital, and useful to your students? (p. 32 in advertising section).



PANORAMIC VIEW OF A MODERN CEMENT MILL

THE STORY OF PORTLAND CEMENT. PART I

John F. Ryan, Portland Cement Association, Chicago, Illinois

Since the dawn of history the building efforts of mankind have been wrapped up in a search for cementing materials with hydraulic capacities. The first crude hovels, chinked and plastered with a mixture of mud and sand, were examples of the first efforts along this line and as history grows clearer the efforts become more closely defined.

Portland cement, as it is known on the market today, is the culmination of that age-long search, although modern man is so used to miracles that he probably doesn't think much about it. To him the fine, grey dust contained in cement sacks does not conjure up visions of permanent rock-hard bridges, towers, dams, and highways. He probably doesn't realize that his concrete sidewalks were once mere limestone and clay—transformed by physics, chemistry, and sweat into a solid year-around footing which keeps him up out of the mud.

And yet, if the commodity were suddenly taken away from him he would immediately set about frantically to find it again, and he would probably be very unhappy and dissatisfied until he did find it.

To the casual eye, portland cement is not mysterious. Its use is so common that the average mind has placed it in a class with flour, or sugar, or shoe leather. Mankind knows, in a general way, that if it takes a quantity of cement and sand and water it may mix these things together and make a stone which will harden in air or water. What it is that transpires within the mass to transform it from several separate things into one uniform solid, is a problem which doesn't weigh on the average mind very heavily. Naturally, after the effect is achieved, mankind is usually interested in results without speculating as to the probable cause.

Cement-making processes today are no secret, although there was a time when the early makers of this commodity labored behind high walls so that the secret of its production might be restricted.

It was in such a place that Joseph Aspdin made the first so-called portland cement at Leeds, England, in 1824. Aspdin, in addition to his capacities as a bricklayer and inventor, was probably somewhat of a showman as well. Chronicles of the time relate efforts of a competing cement manufacturer to discover the Aspdin process through espionage. According to the reports, Aspdin, with grave flourishes of arms and body, was wont to add portions of this and that mysterious material to his calcining product—probably not in any real effort to improve his cement, but through a desire to confuse any possible investigations.

Aspdin was not the first cement maker, even though he is credited with the invention of what we now term "portland" cement. The actual invention of hydraulic cement is lost in antiquity, although Rome was the

ASPDIN'S PATENT

A copy of the patent which was granted to Joseph Aspdin in 1824 for the invention of portland cement.

first nation known to have made extensive use of such a material. Both lime mortars and gypsum plasters were certainly known and used at an early date, for traces of these are found in the pyramids. The cement of Rome possessed qualities which were vastly superior to earlier types, and evidences of its lasting nature are presented in the foundations of Roman monuments and houses and in the rock-hard channels of various Roman waterways existing today.

The chief virtue of the Roman material lay in the puzzolan, or volcanic ash content, which was added to quicklime. This combination resulted in a hydraulic cement—a cement which could be used in underwater construction. Concrete made with this cement was prepared largely in the same way it is today. It is interesting to note that the Romans referred to their concrete as "*opus caementum*," literally "chip work" as referring to the particular nature imparted by the aggregate. The word "cement,"

derived from the Roman term, has in our day been transferred to the hydraulic building material itself without relation to the aggregate.

Until John Smeaton, an English engineer, made certain researches in cement making about the middle of the 18th century, the art was lost for about five centuries. Smeaton discovered that impure limestone which contained certain portions of clayey material possessed hydraulic cementing capacities when calcined. His discovery was used in building the foundations of Eddystone lighthouse, completed in the English channel in 1759. This structure stood the battering of the waves and elements for 20 years before it was replaced by a new and larger structure.

ASPDIN KILNS
Located at the plant of Messrs. Robins & Aspdin, at Northfleet, Kent, London

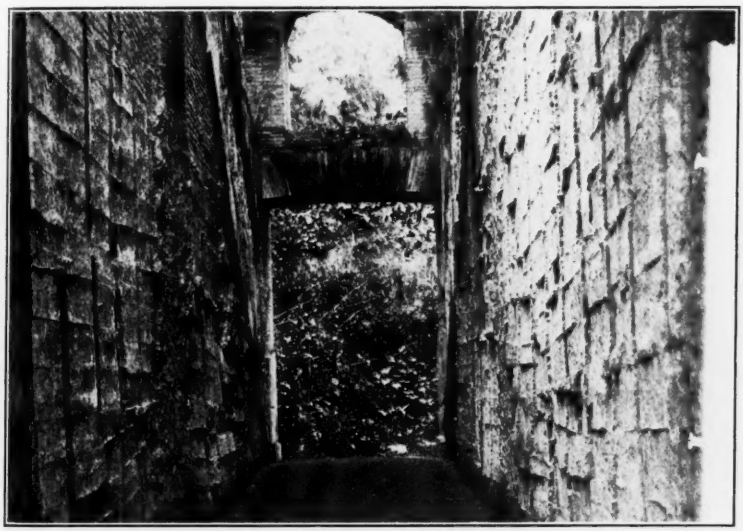
Early in the following century, Vicat made extensive studies in France, establishing through his efforts the first comprehensive data on hydraulic cement chemistry. It remained for Aspdin, however, to patent the now famous portland cement. It was the resemblance of his product to stone from the Isle of Portland which caused him to adopt the name "portland cement."

There are records which indicate that Aspdin's cement, produced at his Wakefield plant, was used in 1828 to construct the Thames River Tunnel, and in 1859, portland cement was designated for use in the construction of the London Drainage Canal by Mr. John Grant, engineer of the Metropolitan Board of Works.

Isaac C. Johnson, manager of the Kent factory of the J. B. White Company, was also an extensive contributor to the early development of cement, and through research and experiment assisted materially in making port-

Notcutt, Plymouth, England

ORIGINAL EDDYSTONE LIGHTHOUSE BUILT BY JOHN SMEATON, 1756–59. THIS LIGHTHOUSE IS NOW SITUATED IN A PARK AT PLYMOUTH, ENGLAND



HOUSE OF AUGUSTUS

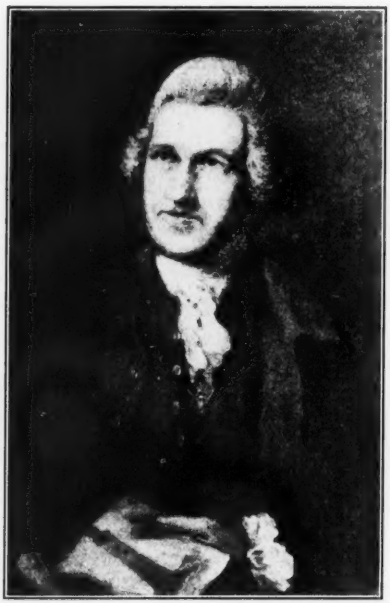
This house was built on Palatine Hill in the first century B. C. The corridor shown presents an excellent view of the Roman concrete construction and the form marks left in the material after the forms were stripped off.

land cement of uniform quality on a scientific and commercial basis. The first portland cement plant was established in France toward the middle of the last century at Boulogne-sur-Mer, and Germany followed suit soon after.

Portland cement was imported into the United States in the early sixties, in limited amounts, and by the time the first home plant was established the imported brands were quite widely used by American engineers and builders. David O. Saylor, in 1872, produced the first portland cement of American manufacture. His plant was located at Coplay, Pa., in what is now the most important cement-producing area in the world—the Lehigh Valley. Shortly after his first manufacturing attempts, another plant was established in Indiana.

Development of the cement industry in America was slow at first. Higher ocean shipping rates and improved manufacturing conditions, including the introduction of the rotary kiln and the subsequent introduction of powdered coal as a fuel, directed trade to the home product.

Following the replacement of the old style vertical kiln, rapid expansion and development came to the industry. In 1890 there were sixteen plants in operation and home production in that year totaled 335,500 barrels.



JOHN SMEATON—1724–92

Smeaton, in 1756, developed a hydraulic cement for use in building Eddystone Lighthouse. To him may be credited the first important researches into the water-acting properties of limes and cements.

During the same year there were produced some 7,082,000 barrels of puzzolan and natural cements, while the imported portlands totaled 1,940,186 barrels. Ten years later there were fifty plants in the United States producing portland cement, and the production had jumped to 8,482,020 barrels. Imports had decreased while natural and puzzolan cement production locally remained about the same.

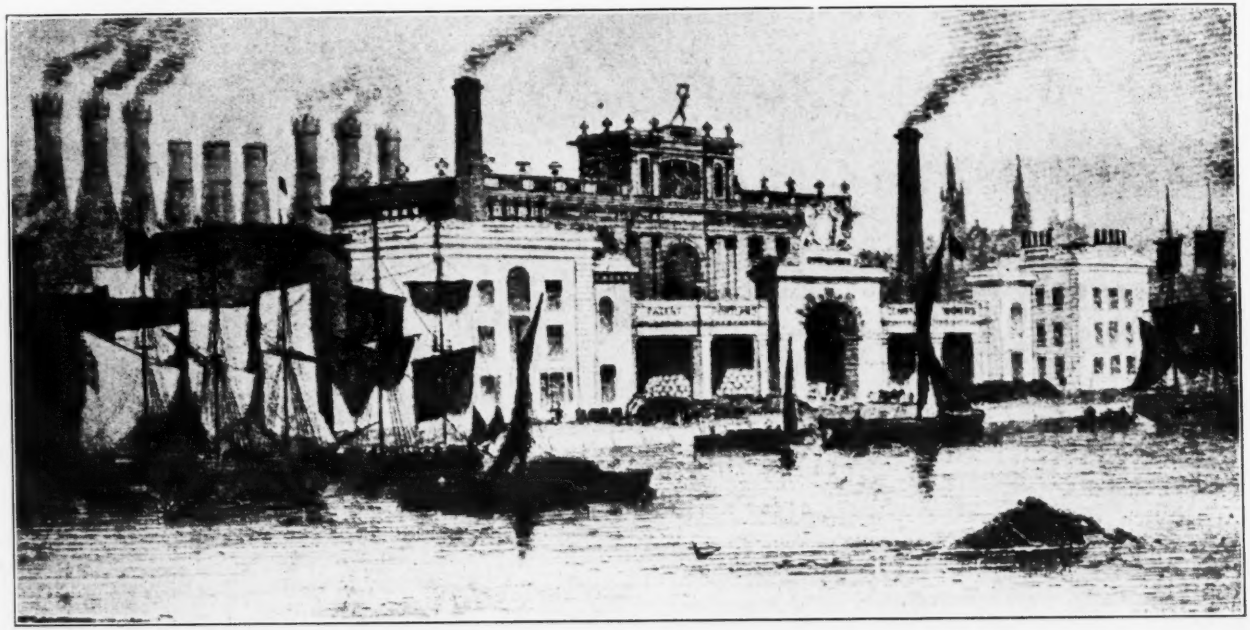
In 1913, there were one hundred thirteen plants in operation, with a total portland cement production for that year of 92,097,131 barrels. Importations had practically ceased, while production of other American cements was almost negligible.

There were some fluctuations in portland cement production during the World War and shortly thereafter. The reconstruction period starting in 1920 sent the output figure to over the 100,000,000 mark, an upward trend which has continued through 1928 when 176,195,000 barrels were produced in one hundred fifty-nine operating plants, a new all-time record.

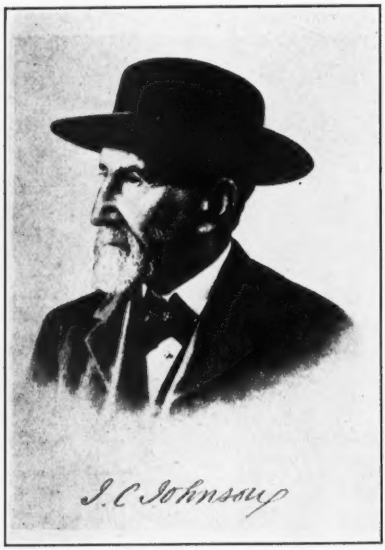
While the Lehigh Valley has been an important factor in piling up this national total, the manufacture of portland cement in America is not restricted to any one locality. In 1928 plants were operating in a total of thirty-three states, which may furnish some insight into the wide range of area in which materials for manufacture may be obtained.

Portland cement has been defined as the product obtained by finely pulverizing clinker, produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

Fundamentally, it is a fairly definite mixture of approximately 60 to 65 per cent lime, 20 to 25 per cent silica, and 6 to 14 per cent iron oxide and alumina with small percentages of other materials. These substances are



ASPDIN, ORD & CO.—PORTLAND CEMENT WORKS AT NEWCASTLE-ON-TYNE



I. C. JOHNSON

Who claimed to have invented portland cement in 1845 while engaged with the J. B. White & Sons cement works at Swanscombe. Johnson believed, and stated with some authority, that he was the first to discover the clinkering process while engaged in a study of cement made by Aspdin.

provided in various combinations of raw materials such as calcium carbonates and silicates of aluminum. The processes of manufacture may differ somewhat with the natural state in which raw materials are found.

Several combinations are used in different cement manufacturing plants in the United States including: cement rock and limestone; limestone and clay; limestone and shale; marl and clay; chalk and clay; limestone and slag; oyster shells and clay. Cement rock is an argillaceous limestone which nearly approaches the correct proportions.

Occasionally deposits of cement rock are found which require no additional materials, but the majority of plants depend upon the familiar limestone of nature together with clay or shale. Blast furnace slag, oyster shells, marl, and other materials are used in plants which have ready access to these materials.

In Germany cement is made from chalk and clay, limestone and clay, or marl and clay. In England raw materials consist principally of chalk and clay; Belgian manufacturers also use chalk and clay, while marl and clay and chalk and clay are used in France.

Invention of the rotary kiln by Frederick Ransome in England in 1885 was probably the most important step in cement industry progress. Prior to that time it had been necessary to form the raw materials into plastic bricks, which were placed vertically in the old style kiln. In an improved type of this previous kiln, a hundred barrels of clinker a day was a good production average. In an average size modern rotary kiln, with its uninterrupted production, 1000 barrels a day is not considered an unusually large output.

Portland cement being, essentially, an artificial mixture, it is necessary that the ingredients be properly proportioned and intimately mixed previous to calcining. This demand results in three distinct steps in manu-

AN EARLY AMERICAN CEMENT PLANT

facture: first, the pulverizing, proportioning, and mixing of the raw materials; second, heating the mixture to incipient fusion; and third, grinding the resulting clinker to commercial portland cement.

Manufacturers throughout the United States have more or less standardized the last two stages, the different plants varying chiefly in mechanical details. Two general processes, however, have been devised for the first stage—the dry process and the wet process.

The great bulk of raw materials used in manufacture is found in a dry state, and many of the plants in America handle the material in that condition throughout the entire process. When this process of manufacture is followed, the latent moisture of the raw materials must be removed to permit efficient pulverization.

In a typical dry process plant using limestone and shale for raw materials, preparation consists in crushing the stone as it comes from the quarry, drying out the latent moisture, and proportioning the mixture. Gyratory crushers or roll crushers assist the first steps of the process, whereinafter the materials are dried separately, in the usual practice, and proportioned.

HORACE GREELEY'S BARN

This structure, built 77 years ago, is one of the earliest concrete buildings in the United States. It was remodeled into a residence for Mrs. Clendenin, daughter of Greeley, and is still in an excellent state of preservation.

The materials are then pulverized in ball mills or in some other manner to achieve a fineness which will allow about 90 per cent of the material to pass through a 200-mesh sieve. Calcining in the rotary kiln is the next step.

The wet process, as the name indicates, provides for a material mixture of high water content. This may be the result of added water or of the natural condition of the materials. The grinding and pulverizing is accomplished on the wet materials in various types of mills, producing a thick liquid called slurry. The slurry is pumped into the rotary kiln from which point on it goes through the same steps as dry process materials.

The kiln, in common use, is a brick-lined steel barrel, mounted on bearings slightly inclined to the horizontal. The slow rotary motion carries the material up the side where it slides down, taking about 5 or 6 hours to traverse the length of the tube. Spiral conveyors are used to introduce the material into the upper portion of the barrel. The lower end is closed by a movable brick wall, through the center of which pass the fuel pipes.

The degree of burning is governed by the supply of raw material, the speed of kiln rotation, and the flame temperature. A temperature of 2500 to 3000 degrees Fahrenheit is necessary to convert the material to clinker. The clinker results at the point of incipient fusion of the raw material, and progresses outward from the kiln into a series of rotary coolers. Clinker is impervious to the elements and may be accumulated in large reserve supplies.

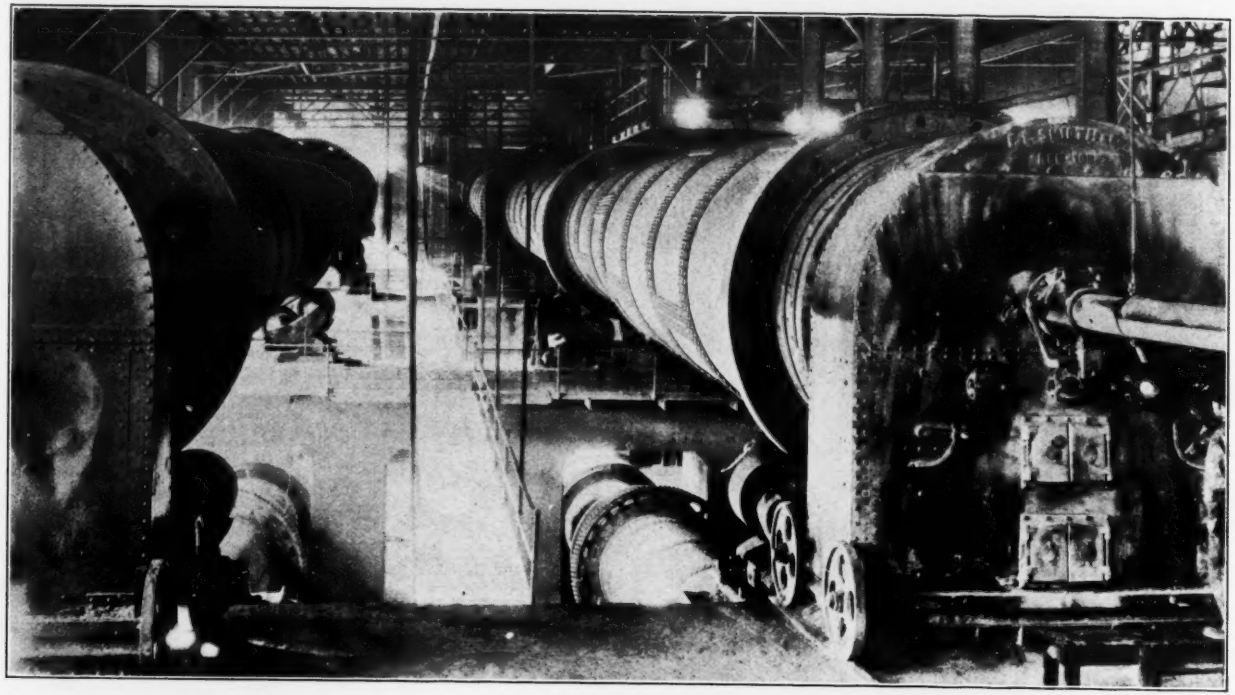
Repairing the Lining of a Kiln

Powdered coal, natural gas, or fuel oil are used as fuels for the kilns. The fuel is injected under pressure and burns with a flame 30 to 40 feet long.

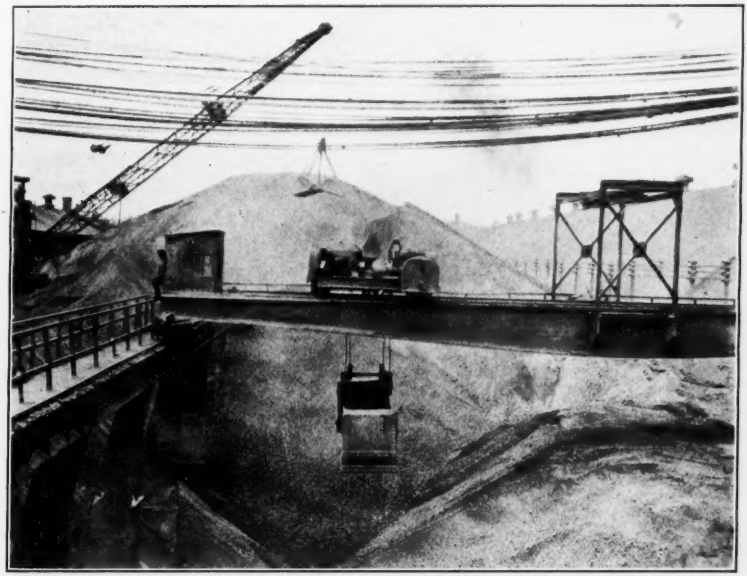
The final stage in the manufacture of portland cement is grinding of the clinker through a process similar to the one used in reducing dry raw materials for the kilns. Gypsum is added at this point to control the time of setting of the finished portland cement. Gypsum must be incorporated after the burning but before the final grinding to secure proper results. From 2 to 3 per cent is usually necessary.

The finished portland cement is then stored for sacking and shipment. Automatic sacking machines are used, replacing hand methods of former years, and insuring an exact content of 94 pounds per sack of cement.

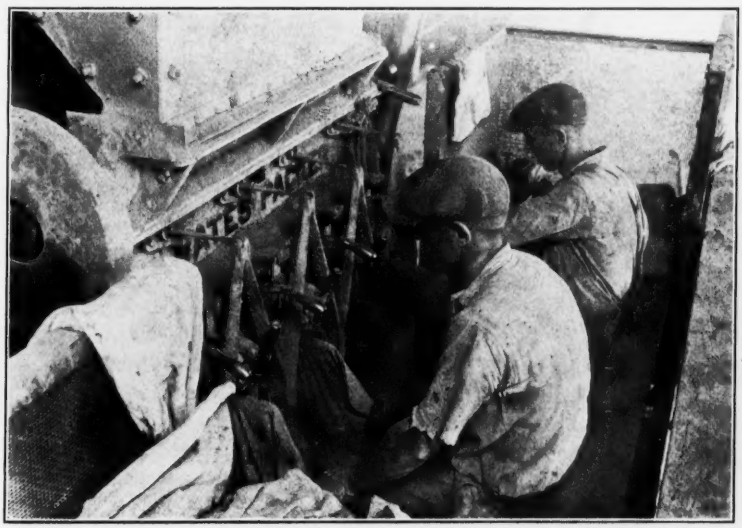
According to statistics compiled by the United States Bureau of Mines, the 176,195,000 barrels of cement produced in the United States during 1928 had a factory value of $276,626,150. This production was about 74 per cent of the estimated capacity of the one hundred fifty-nine operating plants.



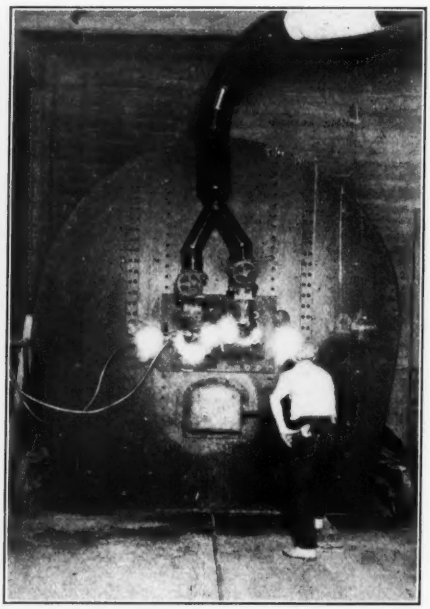
A Battery of Cement Kilns



Clinker Storage



Workers Bagging Finished Cement



THE BUSINESS END OF A KILN, SHOWING DETAIL OF BLOWPIPE MOUNTING

Through the energy of American cement manufacturers, the home market has been developed to an extent larger than that of any other nation in the world. An indication of this is evident in the fact that in 1928, 1.45 barrels of cement was consumed per capita in this country, outdistancing the nearest foreign country by a large margin.

The industry as a whole represented a capital investment of $650,000,000 at the close of 1928, or an investment of $2.75 per barrel of capacity. Thirty-seven thousand wage earners were in the employ of the cement companies last year, and the annual bill of salaries and wages totaled $67,000,000, according to reports from the government and other sources. A plant investment of $17,500 per worker is represented.

Within recent years, the cement industry has felt the pressure of foreign competition in so far as its seaboard markets are concerned. This exterior force operating to reduce the activity of the American manufacturer in certain port areas, has been largely due to lower foreign labor costs and economies of ocean transport.

Belgium, the chief competitor for American home markets, is fortunately situated in regard to available raw material supplies, and this factor, together with cheap labor, has enabled the Belgian cement maker to undersell American producers.

An idea of the scope of the cement industry as it affects other producing industries may be gained from the following figures, compiled from a listing of materials required to manufacture portland cement in the United States in 1928: 11,000,000 tons of coal; 4,500,000 barrels of fuel oil; 24,000,000,000 cubic feet of natural gas; 135,000,000 cloth cement sacks; 200,000,000 paper bags; 47,000 miles of wire to tie sacks; 34,000,000 pounds of lubricants; 200 miles of machinery belting; 23,000,000 pounds of explosives; 970,000 tons of gypsum; 5,700,000 fire brick for lining cement kilns.

THE LIEBIG HOUSE AND THE KEKULÉ ROOM AT DARMSTADT

ERNST BERL, TECHNISCHE HOCHSCHULE, DARMSTADT, GERMANY, AND RALPH E. OESPER, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

It is a remarkable coincidence that two of the greatest chemists of the 19th century were born within the bounds of a comparatively small city. Justus von Liebig and Friedrich August Kekulé first saw the light of day in Darmstadt.

Liebig was born on May 3, 1803. Numerous biographies have made the chemical world familiar with his life and works, but a valuable addition to this literature was the recent publication of a collection of newly found letters. Most of these were written while he was still a student and they afford an intimate view into the process by which his genius was developed.[1]

Kekulé was born September 7, 1829, into a family prominent in official circles.[2] Liebig, his teacher, on the other hand sprang from a very simple family of trades people. At the great Benzol Fest held at Berlin, March 11, 1890, in celebration of the 25th anniversary of the publication of Kekulé's benzene theory, its author recounted many of the salient features attendant upon his development.[3]

The City of Darmstadt, in coöperation with the Vereinigung von Freunden der Technischen Hochschule and numerous patrons and benefactors, has set up a permanent memorial to Liebig in the form of the Liebig Haus, a reconstruction of the house in which he was born. The original building fell a prey to neglect and old age, became unsafe, and in 1920 was carefully dismantled. It has now been rebuilt, with much of the original material, and the old plans and dimensions have been faithfully followed in the reproduction. The Liebig Haus was dedicated on July 7, 1928,[4] in connection with the centenary celebration of Wöhler's synthesis of urea. Many of the rooms have been furnished with furniture of the period of 1800, while others have been utilized for museum purposes. It is intended that the building shall not only serve as a visible example of a middle class dwelling of the time of Liebig's birth, but it is proposed to build up here a technical museum designed to demonstrate the development and far-reaching influences of Liebig's teachings. As funds become available more museum space will be added to house collections relating to agriculture, pharmacy, ..

[1] "Justus Liebig, Briefe nach neuen Funden," Herausgegeben von Ernst Berl, Giessen: Liebig Museum; Darmstadt: Liebighaus Stiftung, **1928.**

[2] Biographical notes in recognition of the centenary of Kekulé's birth may be found in *Chem. and Ind.*, **48,** 870 (Sept. 6, 1929) and *Nature*, **124,** 382 (Sept. 7, 1929).

[3] *Ber.*, **23,** 1302 (1890). See also: "August Kekulé," Ludwig Darmstaedter and R. E. Oesper, THIS JOURNAL, **4,** 697 (June, 1927).

[4] *Z. angew. Chem.*, **41,** 924 (1928).

nutrition, etc. Mementos of other eminent chemists will also be displayed in this planned addition.[5]

Kekulé's memory has been honored in the August Kekulé Room at the Technische Hochschule. Here, in the building devoted to chemical technology and electrochemistry, are preserved and displayed the numerous mementos and souvenirs of this great man. Fortunately, contrary to the usual rule, much material properly a part of this collection is still in existence and is here given a worthy place and reverent care.

FIGURE 1.—HALL AND COURT OF THE LIEBIG HAUS, DARMSTADT

The street known as the "Grosse Kaplaneigasse" traverses the oldest and most closely built part of Darmstadt. Amid such surroundings stood Liebig's birth place, nor did it possess any characteristics to make it appear more luxurious than any of its modest neighbors. On entering the reconstructed house, we find ourselves in a narrow hallway leading to the little courtyard (Figure 1). Three small rooms to the right of the passage are dedicated to the potash industry. This is most appropriate, for Liebig's teachings are primarily responsible for the recognition of the value

[5] The pamphlet, "Justus von Liebigs Geburtshaus—Liebig-Museum," published by H. Hohmann, Darmstadt, contains exterior views and descriptions of Liebig's birthplace before it was rebuilt, as well as the plans for its reconstruction. One of these views was reproduced in THIS JOURNAL, **6**, 220 (Feb., 1929) in the article by R. E. Oesper, "What a Chemist May See in Europe."

of potassium salts in plant growth. Previously, these compounds were thrown away as worthless (*abraumsalze*) because the taste was not that of table salt, but now they have become of immense value, and are sometimes called "noble salts." Figure 2 shows a section through a potash mine, a rock salt model of the church at Stassfurt; a bust of Liebig; specimens of pure potassium salts; and pictures of some of those who have labored to lay the foundations of our scientific knowledge of the chemistry and technical applications of the potassium compounds.

A narrow stairway leading to the second floor is adorned with a copy of

Figure 2.—Potash Industry Exhibit

Trautschold's well-known portrait of Liebig (Figure 3). The rooms on this floor are rather small. Particularly interesting is the kitchen (Figures 4, 5) with its utensils and furnishings of about 1800. The greater part of the home life of the plebeian families of that period was enacted in kitchens of this type.

Three small rooms display plain but substantial furniture, like that which Liebig used in his youth. On the walls are pictures of the master at various ages, a copy of a picture of his parents and his younger sister (Figures 6 and 7); a copy of a picture of his wife (Figure 8) and engravings of his contemporaries (Figure 9). In these rooms are preserved the re-

cently disclosed correspondence of Liebig and his patron Schleiermacher, as well as letters to and from other notables.

Liebig's father manufactured certain chemical products on a small scale and consequently had frequent need for consulting the chemical books of the Court Library. Young Justus was often sent to borrow or return these books, and in his autobiographical notes he relates[6] with what gusto the 13-year old boy soon learned to read all the chemical works possessed by the library. These volumes have been transferred from the Court Library and are now displayed in these rooms of the Liebig Haus.

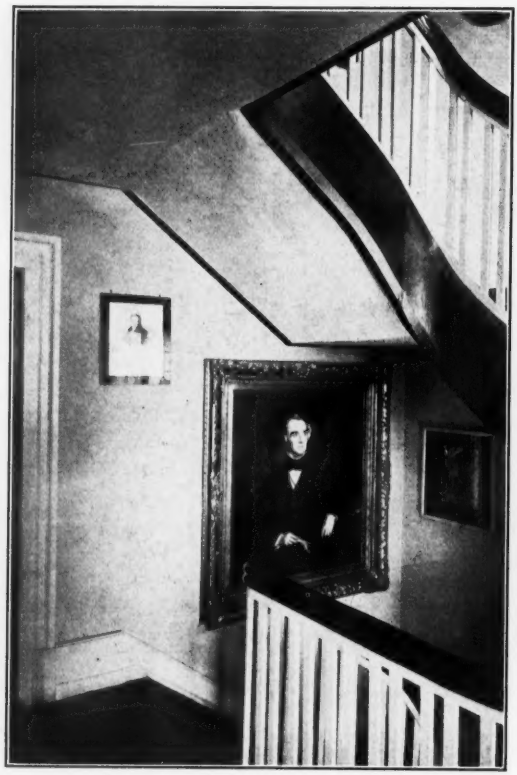


FIGURE 3.—THE TRAUTSCHOLD PORTRAIT OF LIEBIG ON STAIRWAY TO SECOND FLOOR

The upper story contains three rooms which have also been devoted to the display of technical products. Figures 10 and 11 show the space arranged by the I. G. Farbenindustrie A. G. Wonderfully developed crystals of the salts used in fertilizers are a conspicuous feature. Liebig's researches on catalysis are recalled by exhibits of the products of the modern catalytic industries. The present-day control of chemical reactions is exemplified by an exhibit of the hydrogenation of carbon monoxide. In Figure 10, left, may be seen the first high pressure apparatus used by the Badische Anilin und Soda Fabrik for the synthesis of ammonia by the Haber process.

[6] Liebig, "Eigenhändige biographische Aufzeichnungen," *Ber.*, **23**, 817 (1890). See also "Justus von Liebig—Student and Teacher," by R. E. Oesper, THIS JOURNAL, **4**, 1461 (Dec., 1927).

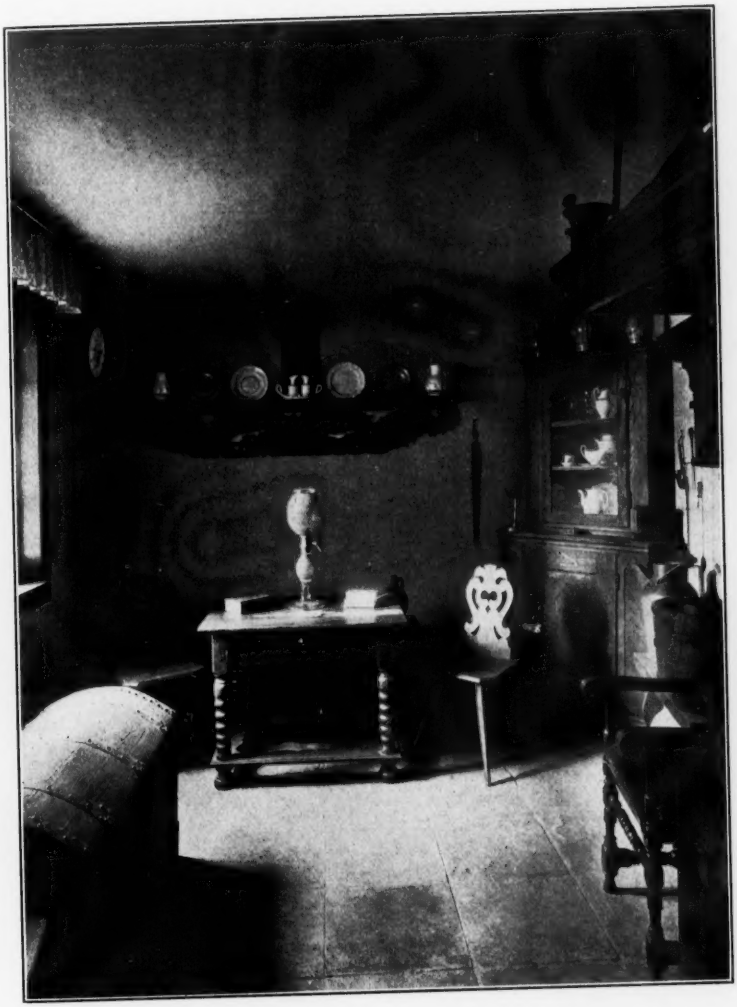


FIGURE 4.—SECTION OF THE KITCHEN

FIGURE 5.—A CULINARY DEPARTMENT OF THE YEAR 1800

FIGURE 6

FIGURE 7.—VIEWS OF LIVING ROOM

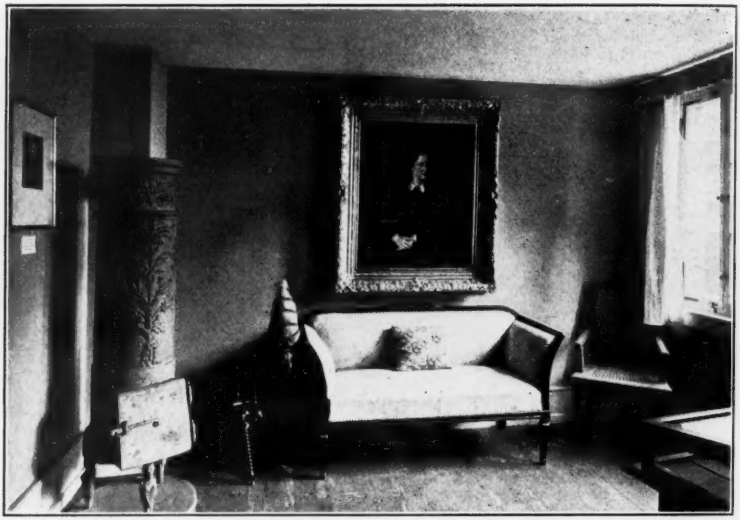


FIGURE 8

FIGURE 9.—PORTRAITS AND DOCUMENTS PERPETUATE THE MEMORY OF LIEBIG'S CONTEMPORARIES

FIGURE 10

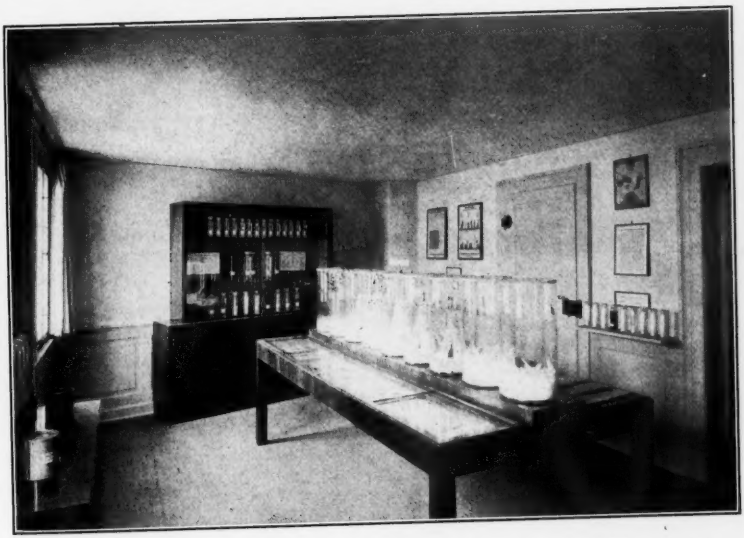


FIGURE 11.—EXHIBIT OF PRODUCTS OF NITROGEN AND CATALYTIC INDUSTRIES

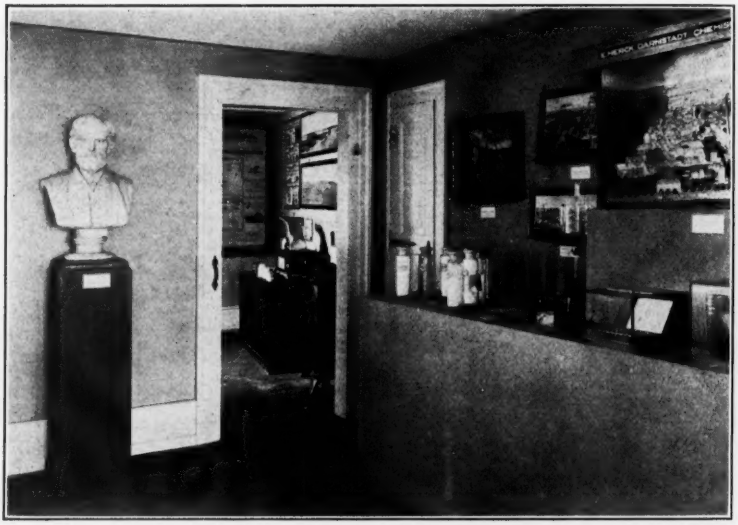


FIGURE 12.—THE E. MERCK COMPANY COMMEMORATES ITS RELATIONS WITH LIEBIG

A second room has been fitted out by the E. Merck Company of Darmstadt (Figure 12). Liebig was closely connected with this organization. Facsimiles of his letters to the then owner of this concern are on display. Samples of the more important alkaloids are exhibited, as well as a portion of Wöhler's original synthetic urea. A striking panorama of the present Merck plant occupies a large part of one wall. The adjoining room (Figure 12) presents the development of the Liebig meat extract industry in Fray Bentos. Here also are exhibited an interesting series of compounds prepared by catalytic hydrogenation.

FIGURE 13.—VIEW OF OLD DARMSTADT, WITH THE COURT LIBRARY IN THE BACKGROUND

A view over Old Darmstadt is shown

FIGURE 14.—EAST WALL OF KEKULÉ ROOM

FIGURE 15.—KEKULÉ AND HIS ASSOCIATES LOOK DOWN FROM THE WEST WALL

in Figure 13. In the background may be seen the Court Library. A bust of Liebig's intimate friend, Wöhler, stands on this landing.

Figures 14, 15, and 16 show views of the Kekulé Room[7] at the Technische Hochschule. Along the east wall are hung pictures of Kekulé (then professor at Ghent) and of his wife. Below to the left is the remarkable bust of Kekulé, by Küppers; to the right, a bust of Liebig by Wagmüller. Between the busts is a large album containing the pictures of all the notable chemists of about 1889. This was presented to Kekulé on his 60th birth-

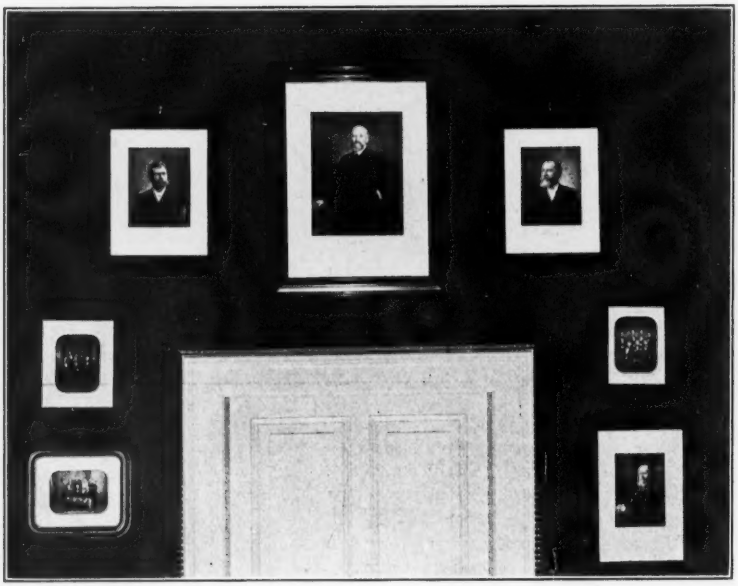


FIGURE 16.—THE NORTH WALL OF THE KEKULÉ ROOM

day. On the wall above is shown a beautiful engrossed memorial presented by the German Chemical Society at the Benzol Fest.

The opposite wall (Figure 15) is adorned with a caricature of Kekulé (from his youthful Heidelberg period) surrounded by a large number of photographs of his intimates at Ghent and Bonn. In Figure 16 are shown pictures of Adolf von Baeyer, Kekulé's first pupil, and of Kekulé's coworkers, Glaser and Brunck, later managing directors of the Badische Anilin und Soda Fabrik. Valuable group pictures from Kekulé's youth,

[7] An account of the dedication exercises, June 25, 1927, is contained in *Niederschrift über die neunte Hauptversammlung der Vereinigung von Freunden der Technischen Hochschule zu Darmstadt.*

and also, quite fittingly, a likeness of Cannizzaro, are displayed. The cases contain personal mementos, his correspondence with eminent chemists and the extraordinarily beautiful drawings made while he was a young man. He was originally destined by his family for an architectual career.

The planning, erection, and furnishing of museums such as the Liebig Haus and the Kekulé Room are definite responsibilities of the successors of such masters. In our rapidly moving times, the triumphs of science are too quickly forgotten and we need constant reminders that the progress of mankind rests in great measure on the achievements of our great men of science. The support of these museums should come from industries and scientific institutions whose very existence is owing to the labors of those whose memory should thus be honored. To such organizations, and to the individual scientists of even moderate means, contributions to this worthy cause should be not only a pious duty but a pleasure.

. . . . .

The recently published volume of the letters of Liebig's student days, edited by E. Berl, is sold for $1.

One of the treasures of the Kekulé Room is the notebook in which Kekulé wrote up the lectures delivered by Liebig at Giessen. A limited number of exceptionally fine photographic reproductions of this interesting record have been made, and are offered at $25.00. The proceeds from the sale of both these books will be applied to the funds of the Liebig Haus and to the sum being raised to finance the erection of a Liebig Technical Museum on the adjoining property. Orders should be sent to Vereinigung von Freunden der Technischen Hochschule zu Darmstadt, Ernst Ludwig Hochschulgesellschaft.

Safe Practices Pamphlets. The National Safety Council, 108 East Ohio St., Chicago, Ill., has recently issued among its Safe Practices Pamphlets No. 56 on "Investigation of Accidents," and No. 64, on "Respirators, Gas Masks, Hose Masks, and Breathing Apparatus," both of which will be of service to the chemical industry.

These pamphlets, which are described as a compilation of experience in accident prevention, treat their respective subjects in considerable detail. The one on "Investigation of Accidents" indicates successful procedure in the investigation of various classes of accidents, so that steps may be taken to prevent their recurrence. Thirty-eight paragraphs are given to an outline of principles to be followed in making investigations and, in addition, there are two appendixes showing the method of investigation used by E. I. du Pont de Nemours & Co., Inc., and by the American Steel and Wire Co.

Pamphlet No. 64 contains a table showing the types of canisters to be used for protection under various conditions, these being classified under ten headings. There is a concise discussion of respirators, of various gas masks and breathing apparatus, compressed air helmets, and special considerations. Both pamphlets are well illustrated and present their subject matter in readable and useful style.—*News Ed., Ind. Eng. Chem.*, **7**, 8 (July 20, 1929).

THE FUNCTION AND LIMITATIONS OF LECTURE DEMONSTRATIONS*

NORRIS W. RAKESTRAW, BROWN UNIVERSITY, PROVIDENCE, R. I.

The practice of lecture demonstration bears the same relation to the teaching of elementary chemistry that the experimental method in general bears to the science itself. I can scarcely imagine proceeding without it. Our science would certainly not be what it is today had not we, and our predecessors, "got down to brass tacks" and worked with the actual material with which we were dealing. Peripatetic argumentation, which we understand was the proto-scientific method of a past age, yields us no bakelite or synthetic methanol.[1]

Nor can we hope to instil enthusiasm or understanding into the beginner by merely talking to him *about* chemistry, without actually showing him some of the processes and materials which are chemical. First-hand information about a subject is more important the less we know about it When we have more factual background our imagination has a little something to stand on, as it were.

The question which naturally presents itself, if we are to make any use whatever of the lecture method of teaching, is: What is the most profitable use we can make of the time at our disposal? There would seem to be four obvious possibilities:

1. Verbal description
2. Theoretical explanation
3. Quiz and recitation
4. Demonstration and experimental illustration.

The first of these is perhaps the least profitable. Although it may be true that an impression gained from written words is strengthened by a simultaneous auditory impression, still the mere intonation of material which is perfectly straightforward reading in a textbook, the properties of materials and information of that sort, is hardly the best use of a teacher's lecture time.

* Read before the Symposium on "Lecture Experimentation," Division of Chemical Education of the American Chemical Society at the Columbus Meeting, April 29, 1929.

[1] It is said that one of the curious questions which was often debated in ancient times was whether or not an empty vessel would hold as much air or water as a similar vessel filled with ashes. There is, of course, an object lesson in this in connection with the use of the experimental method. The natural question, "Why not try it?" offers an excuse for an amusing and interesting "experiment:" Take two wide-mouth bottles of the same size and fill one with "ashes," in the form of activated charcoal (!). Introduce a funnel-tube, stopper, and outlet tube and displace the air contained by pouring in water. Collect the air over a pneumatic trough in the other bottle. Usually this bottle can be filled with air three or four times from the bottle which contained the "ashes."

A large portion of our time is legitimately taken up with what may be called theoretical explanation. Knotty problems of all sorts baffle the student, and light is often best shed by a verbal explanation, which is more adaptable and flexible than a textbook page.

Some teachers break the formality of their lectures by frequent quizzes and recitations, even in large classes. But many of us feel that quizzing or recitation is best done in smaller sections. Usual experience, I think, is that the atmosphere of a large classroom is too formal to produce good results.

The proportion of time which should, ideally, be given to lecture demonstrations cannot be stated, but the danger of making it too small is far greater than that of making it too large. Particularly is this true when a course is so conducted as to follow a textbook closely. Nothing is more deadening than to hear a lecture which is a mere repetition of a chapter from a text. In such a case the teacher might far better use all his time in actually showing, as far as possible, all that the textbook describes.

Of course it may be argued that the ideal plan is to do away completely with the lecture method, which has been described as a method by which information is transferred from the lecturer's notebook to the student's notebook without any intermediate process of cerebration whatever. Most of us, however, from practical considerations at least, are not ready to give it up entirely. And the use of experimental demonstrations fortunately relieves the situation to a large extent.

Even the most inexperienced teacher knows how difficult it is to get the average student to form a concrete mental picture. Those of us who teach elementary chemistry are often criticized for teaching our students things which, strictly speaking, are not true. Entirely aside from the difficulty, in these rapidly moving times, of knowing from day to day just what is true, there is also a point which is often unappreciated by those who take our products in charge later. One must start somewhere and the first problem is to get the student to form *any* kind of a definite concept. Even a shaky scaffold is better than none at all. For after all it is only a scaffold, and you can nail more boards on it to make it stronger, once you can get a foothold on it.

Granted that our ultimate object is the ability to think abstractly, this can be attained only by learning first to think concretely. Only by actual demonstration can purely descriptive material be made to mean something to the beginning student. Even though a "demonstration" is no more elaborate than holding up a flask of water when one is discoursing on the properties of liquids, it serves its purpose. Like an oriental idol it focuses the attention, making definite and concrete what would otherwise be only meaningless words.

An actual sample of urea, when one explains the significance of Wöhler's

synthesis in the development of organic chemistry, gives the mind something real to grasp. The use of lecture specimens of this sort on a large scale, especially in organic chemistry, has been violently debated pro and con. The objection that most of them look identical and that a person might as well see any one as another does not entirely dispose of the matter. Who of us but feels a thrill over a pure sample of a rare earth salt, even though it is only "a white crystalline solid?" And we want our students to learn to be equally appreciative.

Molar quantities, incidental to the understanding of molar and normal solutions, become something more than abstractions when weighed samples are put before a class to see. And with a little excitation the imagination can perhaps see that each little pile contains the same number of molecules. To be sure that is not thinking mathematically, as a student of chemistry must eventually learn to do, but it is the kind of thinking that must be learned first.

It means nothing to the entirely uninitiated to read that "nitric oxide is a colorless gas which turns brown on exposure to the air." But it only takes an instant to *do* it, by taking the cover off a jar.

There are a few critical objections which have been made to the general practice of lecture demonstration which, although they contain certain elements of truth, refer not so much to the use of the practice as to its misuse.

The first of these is the purely specious one that lecture experiments require elaborate equipment and much time and labor on the part of the teacher. Concerning the time and labor there is not a doubt, but as to the equipment it is surprising what can be done with a very little.

More serious is the objection that students get the impression that chemistry consists of nothing but beakers and flasks and the more readily visible (and audible!) reactions which best lend themselves to class use. Corresponding to this is the English schoolboy's use of "stinks" as a synonym for the subject of chemistry. Which, of course, reveals a lack of understanding of the relation of chemistry to the perfume industry. There is a real danger, however, of the student's getting a mistaken idea of the true content of chemical science. Students often come to college with such mistaken ideas and learn, only after a year's further experience, that chemistry is more than a flash, an explosion, and a lot of pretty colors.

It is hard to resist the temptation to run to the purely spectacular in lecture experiments. While it is scarcely defensible to introduce an experiment simply because it is spectacular, on the other hand the striking nature of an experiment with a real purpose is a strong point in its favor.

It is sometimes hard to draw the line. The noise produced by pushing a potassium chlorate tablet soaked with a little phosphorus solution from the table onto the floor is perhaps the only real point one gains from the

experiment. On the other hand, the sudden setting of a silicic acid jelly,[2] which is certainly striking, carries a more definite point with it. Similarly, the burning of a piece of wood in melted potassium chlorate,[3] than which there is scarcely anything more spectacular, is a long-remembered incident in a lecture on combustion and oxidation. The action of a little blood on some ordinary hydrogen peroxide,[4] which is quietly spectacular, is instructive either in connection with the properties of hydrogen peroxide or as a colloidal experiment in reference to stabilized foams. The combustion of zinc dust and ammonium nitrate, ignited with a drop of water,[5] might be questionable from a conservative standpoint.

Lecture demonstrations often fail in their purpose because the lecturer cannot bring himself to see them from the standpoint of the class. Experiments may, for example, be done on too small a scale, so as not to be visible beyond the first row.

The use of the lantern for projecting experiments on the screen is coming into increasing favor. Numerous possibilities are opened up by this means. A whole series of indicator colors (perhaps in connection with a discourse on indicators and hydrogen-ion concentration) can be thrown on the screen by means of a home-made test-tube rack which will slip into the lantern in place of the slide holder. Another simple home-made device makes possible the projection of the critical phenomena in sulfur dioxide and the disappearance of the meniscus at the critical temperature. And nearly every one is familiar, I am sure, with J. J. Thompson's classical "floating magnet" experiment, which can easily be projected in a reflecting lantern and which is immensely valuable in developing the electron theory of atomic structure. These are only a few random examples of the use of the lantern.

A sense of the dramatic is essential to success in the art of lecture demonstration. A good experiment is sometimes ruined because something is allowed to distract the attention at the critical moment, or else the point is missed because of too much hurry at the wrong time.

A proper choice of conditions determines the success of an experiment. Burning a tuft of guncotton may very well illustrate rapid combustion, but the experiment remains in the mind longer and with added emphasis if it

[2] Pour together quickly equal volumes of *N* acetic acid and sodium silicate solution (sp. gr. 1.10). Hold the beaker in the hand for a moment until the jelly has "set" and invert suddenly.

[3] Melt $KClO_3$ in a large, hard, glass tube (about $^1/_3$ full) and drop into it, without previous ignition, a wood splinter. Beware of violent spattering.

[4] Put about 50 cc. of commercial H_2O_2 solution into a tall one-liter cylinder and add 5 to 10 cc. of blood. A strong, dense foam will rise to the top of the cylinder, which can be inverted without spilling.

[5] On top of a small layer of powdered ammonium nitrate (containing about one-fourth ammonium chloride) place a similar layer of zinc dust. Make a little hole in the middle and add here a drop of water.

is done on the palm of the hand rather than on the table. One's surprise that it does not burn the hand is worth more than a long explanation.

It is perhaps useless to dwell on the necessity of careful preparation and rehearsal for lecture demonstrations, but one other point is even more important for success. Lecture experiments must be done with enthusiasm; the lecturer must obviously take pleasure in doing them. Because of this, younger teachers sometimes succeed better than older and more experienced ones. Unless one is prepared to put as much enthusiasm into his lecture experiments as into his own research he had better not attempt it, especially since the practice of lecture demonstration on a large scale will most certainly limit the time one can devote to research.

There is one important phase of this question which I have not entered into, and that is the relation between lecture demonstrations and individual laboratory work. This question has been the subject of so much controversy with so little basis for positive judgment that we will do well to let it alone for the present. There is good reason to suspect, however, that much that we have tried to accomplish by means of individual laboratory work can be done more effectually and with less effort—at least for students who are not specializing in chemistry—by means of class demonstrations. Particularly might this be true if we adopt the suggestion of Professor Schlesinger and divide our classes into much smaller groups for lecture purposes. We need more experimentation along these lines.

Carbon Dioxide Temporarily Clears Mind of Insane Patients. Inhaling carbon dioxide gas temporarily restored the sanity of mentally deranged patients at the University of California Medical School.

The experiments were conducted at the request of Dr. A. S. Loevenhart and Dr. Ralph M. Waters of Madison, Wisconsin, the former of whom has since died. The tests were made by Dr. Chauncey D. Leake and Dr. Mary E. Botsford, of the University, with the help of Dr. Arthur E. Guedel, of Beverly Hills, and some six other physicians.

Eight trials of the treatment were made on five cases of the type of insanity known as *dementia praecox catatonia*. In all but one trial there was a fleeting return of intelligence which enabled the patient to answer questions rationally, or to exhibit recognition of their surroundings. These periods of rationality lasted from ten to fifteen minutes.

In the case of a young man 25 years of age who has lain in bed in a stupor for several months, inhalation of the gas clarified his mind sufficiently to answer a number of questions, to volunteer a few rational statements concerning himself, and to laugh. After about nine minutes he relapsed into his former state of muscular rigidity, paleness, and fright.

In a report of their findings, the experimenters state that the results are interesting enough to warrant further experimentation on the effects of continued treatments with carbon dioxide in such cases.—*Science Service*

THE MODERN CHEMICAL LECTURE HALL AND PREPARATION ROOM*

JESSE E. DAY, THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO

Education, in Mark Hopkins' day, was acquired to a large degree through a conference between Mark and his one pupil. The rather steady increase in class size brought the recitation, or quiz, as it is sometimes named. For a time during its earlier history the recitation was not an occasion for a student-teacher discussion of the subject, but largely one during which the teacher attempted to measure the degree of acquisition of knowledge on the part of the student. Many teachers still refer to this form of class contact as a conference period even though any semblance to a real conference may be largely if not totally lacking. In the more advanced stages of learning, the quiz has, for one reason or other, been replaced by the lecture in certain types of collegiate training.

Scarcely more than 40 years ago elementary chemistry was still being presented in many of the American colleges in much the same manner, except for a few demonstrations, as was a course in English, that is, by the lecture-recitation method. Previous to this forty-year period, a few teachers of first-year chemistry had the courage to require an hour per week of laboratory work of their students. From this modest beginning the number of laboratory hours per week has gradually been increased to as many as six hours until, at present, chemistry is regarded as being essentially a laboratory science. It is now quite appropriate to designate officially a building in which chemistry is taught as the *chemical laboratory* rather than as the *chemistry building*. For the past four decades, most teachers of chemistry have considered lecture, quiz, and laboratory as the necessary integral but interdependent parts of a well-balanced course in first-year chemistry.

During the last twenty-five years of this forty-year period there has been an increase in the student enrolment as great as 500 per cent in many of our colleges and universities. This growth in enrolment has been accompanied by at least a proportionate growth in the size of the chemistry lecture groups, these groups ranging in size from 25 to as many as 400 students in extreme cases. There has been an expressed difference of opinion as to what should be the nature of the chemical demonstrations included in the lectures for these groups. In fact, many of the lecture experiments now in use have been brought down through the years, without change except for a slight attempt at increasing the size of the apparatus used. The marked advances in the knowledge and theory of chemistry have been accompanied by the substitutions of appropriate lecture experiments for some

* Read before the Symposium on "Lecture Experimentation," Division of Chemical Education of the American Chemical Society at the Columbus Meeting, April 29, 1929.

no longer in the saddle. Opinion as to the value of the pyro-technic type of experiment is still divided but with a favorable tendency toward its elimination. Visual education, as represented by both the kinetic and static kind of picture, has for more than fifteen years been riding on a wave of enthusiasm. Barring these changes we are still a bit inclined to give the same lecture experiments in the same old way at the same old table, regardless of the size of the lecture unit.

Perhaps the talking movie will have its fling in chemistry training in the very near future. In recent months there has been an effort suggesting the possibilities of this cinema innovation in the presentation of chemistry. The present talking movie of the theatre world is apt to remind the audience of the ventriloquist, the moving lips of the speaker being in one place and the voice in another. Doubtless this unsatisfactory feature will be surmounted, but even when perfected the author is extremely doubtful as to the "talkie-movie" ever becoming a satisfactory substitute for the lecturer with an inspiring personality.

It is also possible to "listen-in" on the now senseless conversations between molecules when finding their geometric assignments in crystal formation. This voco-micro study has been realized largely through the modern sound amplifying devices. If this method of study is ever extended so as to afford an intelligent insight into chemical reactions, it may have a future.

These changes in the method of presenting the subject matter of chemistry to the present-day larger groups of students have made the lecture hall a matter of extraordinary consideration.

The modern lecture halls, both those for academic and for commercial use, have certain needs in common. The architecture embodied in the theaters of the several kinds is—minus their ornament and detailed fresco—slowly being patterned in the large lecture halls of academic plants. In conformity to the building code a portion of the entranceways of the larger lecture rooms are now of the outside type. This method of outside traffic communication has another advantage in that it eliminates the annoying tramping of large groups of students through the building corridors. The old location of doors which compelled the late comer to pass his instructor enroute to a seat is also rapidly being relegated into history.

The matter of acoustics is the greatest anathema of the architect and contractor in the plan and construction of these halls. Despite the care taken to secure a resonance of the desired quality, it is rather seldom that the first efforts are completely rewarded with success. As the writer is quite unsophisticated in regard to this problem, he could probably contribute nothing to the list of commonly known interferences. It might be pointed out, however, that the theater has carpeted floors, tapestried walls and heavily draped entranceways. For good reason, collegiate lecture halls are not accorded this treatment.

In the effort to increase visualization on the part of the audience the balcony and a lessened depth and increased width of the main floor are modern features of the lecture hall. Unfortunately, halls constructed a decade or so ago resembled the moving picture hall of that day with respect to their breadth and depth. The more frequent use of motion pictures as a part of educational procedure has marshaled in the lantern booth, constructed in conformity to the National Underwriters' Code. This innuendo is being accompanied by the general use of modern artificial lighting, which offers at least three advantages: (1) the lighting is of a uniform character regardless of the occasion; (2) the blackboard glare is eliminated; and (3) the control of the lighting for the use of the lantern is simplified. For some reason no one seems to have perfected the convenient replacement of "dead" lamps in high ceiling rooms. The use of ceiling flood lights with alternate lights focused on the demonstration table and blackboard, respectively, is a decided improvement in illumination. Another excellent aversion of blackboard glare is being used in a few lecture halls by the substitution of plate glass with a blackened back and a frosted front for the classical slate board.

The elimination of the window in the lecture room has been accompanied by a more satisfactory form of ventilation. The ideal system, however, has not as yet been realized as is evidenced by the lower extremity discomfort frequently experienced by the occupant of the auditorium chair. Humidifying and other air-conditioning devices are in general use. As a majority of the colleges and universities are located either in the smaller centers of population or else outside the smoke and grime area of the larger centers, the use of air-washing machinery is seldom necessary.

The selection of a satisfactory amphitheater chair is a matter of debate. Some institutions, because of the lack of floor space, have been obliged to economize by using the semi-folding type of chair. It should be remembered, however, that moving parts always involve adjustment and repair. There is no type of folding chair arm in use at present which does not soon show evidence of instability in some form. The proper spacing of chairs is extremely important. During the winter months the student generally finds it necessary to take his top-coat as well as his student equipment with him to his lecture chair. For the fixed arm and seat type of pedestal chair a satisfactory distance between reference points on adjacent chairs in the same row is about 26 inches and in succeeding rows is about 37 inches.

Every lecturer and his audience have suffered from the limited means of communication between the lecturer and the lantern operator. It is at least disconcerting to hear the signal "next slide, please," a thump on the floor, or the "click-clack" of a piece of metal. The signal light is a decided improvement over any of these. For more extensive instructions to the

operator, the telephone is an unquestioned necessity. A new type of lantern, so constructed that it may be operated from the lecture table to the extent of about seventy slides, completely eliminates the lantern operator. A simple electro-magnetic switch with the control in a convenient place on the lecture table also gives the lecturer complete control of the lighting.

The day of laboriously "chalking" on the blackboard diagrams of a complicated or otherwise extensive character should be no more. Good lecturers are not necessarily rapid sketch artists. To an appreciable extent, the making of diagrams has been replaced by the employment of charts. The chart showing the periodic arrangement of the elements and also the ones giving the chemical activity series ought to be kept permanently in place on the wall. Even the chart method of depiction has its limitations as it is extremely annoying to be constantly "putting up" and "taking down" those charts needed for the day only. The use of wall chart boxes is satisfactory, providing the charts required are not too numerous. It must be remembered that chart boxes are not only mechanically troublesome but also interfere with the simplicity and decoration of the room. The stereopticon (or balopticon) is of value in this connection up to the point where the frequent modification of the lighting begins to interfere with the undivided physical and mental attention of the audience. It still remains for some genius to make possible the more satisfactory simultaneous or alternate use of the projection screen and the blackboard, or demonstration table, without the constant annoyance of illumination tinkering. The nearest approach to the ideal arrangement consists of the use of flood lights previously mentioned and the single electro-magnetic control of all other lights, both from the projection booth and the lecture table.

Although the author is not qualified to discuss the merits of the several kinds of projection apparatus, he does not feel thus constrained in the matter of screens. The aluminum screen, despite its cost, is doubtless the best portable type the market has to offer at present. It may be permanently kept ready for use or else attached to a spring or other mechanically driven type of roller. Here again is encountered the well-known imperfections of mechanical devices of this type. In addition, sagging of the roller, after a few years of use, results in the creasing of the curtain. Without question, the most satisfactory screen is in the form of a properly surfaced and decorated wall panel. Even if the panel does develop imperfections, these can be corrected without difficulty and generally at a small cost.

The demonstration or lecture table is the *sine qua non* of the chemistry lecture hall. The early lecture table was constitutionally an enlarged edition of a student locker outfit. As lecture rooms of greater capacities

became necessary, correspondingly larger lecture tables were installed which afforded not only larger areas for demonstrations but also more storage space for more and slightly larger equipment. The items generally considered the unchallenged parts of the table are: (1) alternating (power) and direct current services and controls; (2) gas; (3) tap and distilled water and a waste system; (4) compressed air and suction; (5) hood; (6) a limited amount of storage; and (7) outlet boxes with leads to large-face volt and ammeters. To these may be added controls for the lantern and the general illumination system; a special illumination device for certain experiments; and steam.

In general, the top of the lecture table should be kept as free as possible from unsightly permanent equipment. The necessary openings for sinks and for hood connections should be provided with well-

FIGURE 1

S—Steam outlets; *A*—Compressed air outlets; *G*—Gas outlets; *E*—A.c. and d.c. outlets; *H*—Hot water; *C*—Cold water; *W*—Water waste. Distilled water, suction, volt and ammeter connections, lantern and illumination controls are not shown.

fitted but easily removed covers. If the sinks are of sufficient depth, the water-cocks may be located below the under level of the table top.

The gas burner, to a considerable degree, has been supplanted by the electric heater in lecture demonstrations. It is quite essential, therefore, that the electrical service outlets for power use be distributed at intervals on the operator's side of the entire length of the table. The direct current control panel should be of the removable type and because of its small depth may be placed in a vertical position immediately in front (operator's side) of the large sink.

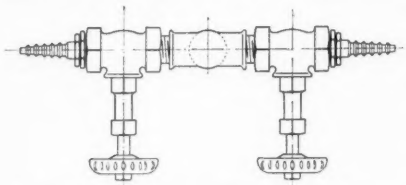


FIGURE 2.—FRONT VIEW OF TYPICAL SERVICE CONTROL AND CONNECTOR ON STATIONARY SECTION OF LECTURE TABLE

The gas, compressed air, suction, and drain services should also be at intervals along the entire length of the table. Lecturers are extremely familiar with the annoyance of the projecting type of service distributors. Almost complete relief from this may be had by the use of ample top-overhang and the wheel type of cock with the connector pointed downward, or horizontally (see Figures 2 and 3).

The type of hood and its location doubtless constitutes the most troublesome problem of the chemical lecture table. In the less modern type of lecture hall, the hood is frequently located in the blackboard wall—a very unsatisfactory arrangement. The removable type of hood when connected to a downdraft on the table top is, perhaps, less disadvantageous. The value of demonstrating with gases having pronouncedly unpleasant odors and irritating characteristics is not beyond question except in a few instances.

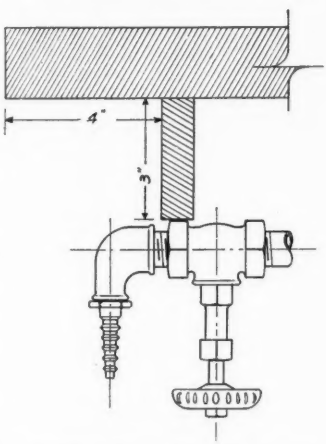


FIGURE 3.—SIDE VIEW OF TYPICAL SERVICE CONTROL AND CONNECTOR ON MOVABLE SECTION OF LECTURE TABLE

With the modern type of preparation room adjacent to the lecture room extensive storage space under the lecture table is quite superfluous. A few drawers for small pieces of regularly used equipment, such as towels, burners, matches, etc., are necessary. A cabinet for the temporary disposal of certain large pieces of demonstration apparatus will be found convenient but not necessary if a lecture assistant is available.

In recent years, educational institutions have been concerned about the more continuous use of their classrooms, particularly the larger lecture halls. For the chemistry halls this furtherance in economy has marshaled in the sectional table, one part being movable to and from the preparation room. The movable section type is in the experimental stages in several universities. This innovation has brought forward a new problem in the form of service outlets on the movable section, particularly that involving the convenient disposal of waste liquids. At the Chemical Laboratory of The Ohio State University the two duplicated movable sections have complete service with the exception of a large sink. (Figure 1.) The incoming pipe service is hooked to that on the stationary section of the table by means of pressure-hose couplings. The upper end of the main waste line on this section is about three inches below the table top and the lower end, when the table is in position, overhangs a fixed main drain.

The preparation room should be located at either side of the lecture hall. This room should be as completely equipped as any private laboratory. As most preparation rooms are of the same height as the lecture hall, sufficient altitude for a balcony, fitted with apparatus storage cabinets, is afforded. Service to the balcony should be available by means of a dumbwaiter fitted with several shelves. If the lecture hall table is of the sectional type as described earlier in this paper, then the preparation room plans must include a turn-table and sufficient trackage in both number and length to accommodate the movable sections of the lecture table. This room should also have a modern signal and telephone system connected with the lecture table.

When completed, the lecture hall and preparation room in the new Chemical Laboratory at this University will be modern in all of these respects.

The present-day chemical museum with its larger and more extensive mineral collection has given rise to a problem in transportation and classroom exhibition which did not exist a decade or two ago. The chemical museum at this University is located on the first floor of the Chemical Laboratory and the lecture table is on the basement level. The building contains an elevator. A rubber-tired, ball-bearing cart has been designed so that the glass-covered museum trays may be placed directly thereon, the cart taken down on the elevator and wheeled to the student side of the lecture table. This method of transfer and exhibit will add greatly to the life of the specimens.

The abolition of the radium paint industry in the United States is recommended by the United States Department of Labor, because of the danger to the workers. Although the industry employs only 250 workers, 15 have died, and there are 18 cases of disease due to employment in the industry.—*Chem. Age*

TYPICAL OXIDATION-REDUCTION REACTIONS IN GENERAL CHEMISTRY*

STUART R. BRINKLEY, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT

The reactions which involve oxidation-reduction are so numerous and varied that their discussion in a short paper is difficult. It is, therefore, deemed advisable to limit this discussion to types of reactions which are suitable for inclusion in freshman courses in general chemistry; and to illustrate the point of view from which, in the opinion of the writer, they may be studied in the most effective manner. Such reactions are normally scattered throughout the course; and a large body of concepts, essential to a clear understanding of the subject by the student, must perforce be omitted from this presentation of the subject.

Teachers quite generally agree that the word "oxidation" is an unsatisfactory name for the phenomenon to which it is applied; but no one has been able to persuade chemists to adopt any other name for this phenomenon. Regardless of any personal preferences we may have on the subject, the name "oxidation" refers to that broad class of reactions in which valence changes occur, and seems likely to continue to do so. Since the concepts of atomic structure furnish the most satisfactory basis for an interpretation of valence and of changes in valence, the writer prefers to postpone the discussion of the principles of oxidation-reduction until the student has learned the simpler concepts of atomic structure. In the meantime, the reactions of oxygen with other elementary substances can be classified satisfactorily under the topic, "direct union with oxygen." It seems that it is time for teachers of elementary chemistry to drop completely the false emphasis upon the rôle of oxygen in oxidation, and to cease basing a definition of a general phenomenon on a special case, which is so limited in its applications. The process of neutralization is usually first studied using sodium hydroxide as the example of the base, yet no teacher tries to explain all reactions of neutralization in terms of sodium hydroxide. Why, then, should we insist that oxidation-reduction is a phenomenon to be interpreted in terms of oxygen?

Concepts of Atomic Structure

If oxidation-reduction is to be based on ideas pertaining to atomic structure, the question now arises: "At what point in our courses shall we introduce this hypothesis?" For those students who have had preparation in secondary-school chemistry, it has for a number of years been our practice to teach atomic structure at the beginning of the course. No

* Presented before the Symposium on "Lecture Experimentation," Division of Chemical Education, at the 77th Meeting of the American Chemical Society, Columbus, Ohio, April 29 to May 3, 1929.

attempt is made to present these concepts in a dogmatic manner; but, on the contrary, a positive effort is made to give the student a picture of an evolving theory. We feel, however, that the beginner needs a background upon which to base these concepts, and that the earliest feasible point to teach atomic structure in the beginners' course is just before the development of the ionic theory.

That the atom itself is a mechanism set up to explain the behavior of matter has been pointed out by Bridgman.[1] At the Symposium on Atomic Structure at the St. Louis Meeting of the American Chemical Society, Rodebush[2] urged that, since the atom is a construct, it should be designed in the simplest possible manner that will serve the purpose. The attempt to give the average freshman an elaborate picture of atomic structure is futile. The fundamental ideas which he finds useful are that an atom consists essentially of two parts: (1) a nucleus containing the excess of protons over electrons represented by the atomic number; (2) an outer portion containing the number of electrons equal to the atomic number. Certain numbers of extra-nuclear electrons yield unreactive atoms, as shown by the fact that helium (2), neon (10), argon (18), etc., are inert whereas the atoms of intervening atomic numbers are reactive. This leads to the concept of stable configurations or successive "shells of electrons." At this stage of our knowledge, it matters little to the student whether the electrons are situated at the corners of cubes, as pictured by Lewis and Langmuir; are revolving in orbits at certain energy levels, according to the Bohr hypothesis; or are in some other conditions. In the interest of simplicity, it seems justifiable at present to picture the atom as made up of electrons in a series of "shells," centering at the nucleus, the whole being pictured as having spherical symmetry. The chemist is concerned primarily with the electrons in the outermost group—the valence electrons—which group is supposed never to contain more than eight electrons.

Valence in Terms of Electrons

In terms of atomic structure, two concepts of valence are commonly held. One of these, known as polar valence, is the result of a complete transfer of electrons from one atom to another, as in the reaction of an elementary metal with an active non-metal. The compounds, formed in such reactions, consist of electrically charged particles, because the loss of electrons leaves an ion containing a greater number of protons than electrons, and the gain of electrons yields ions containing an excess of electrons. Such compounds dissociate into ions when they are dissolved in water.

[1] Bridgman, "The Logic of Modern Physics," The Macmillan Company, New York, 1927.

[2] W. H. Rodebush, *Chem. Reviews*, **5**, 510 (1928).

A second concept of valence, known as non-polar valence, applies to those cases in which electrons are shared by two different atoms, as in the case of carbon and chlorine in carbon tetrachloride. The name "valence number" has been applied to this type of valence. The properties of a large number of substances are such as to indicate that they lie in the borderland between the polar and the non-polar compounds; *i. e.*, that they contain positive and negative groups which, nevertheless, do not separate as ions in solution. Such cases may be explained by the assumption that the pairs of shared electrons are nearer to one atom than to the other, as in the case of sulfur and oxygen in the sulfate ion. In such cases, a negative valence number is assigned to the atoms having the electron pairs displaced toward it, and a positive valence number is assigned to the atoms which hold the shared electrons less closely. The numerical value of the valence number is calculated by the use of arbitrary assumptions. Thus, the sulfate ion, SO_4^{--}, exhibits a negative valence of two. Each oxygen atom is assumed to have a negative valence number of two, making a total of eight units of negative valence. Hence, sulfur exhibits a positive valence number of six units in the sulfate ion.

Electronic Changes during Changes in Valence

Ions possess a positive valence numerically equal to the number of electrons their atoms have lost. Consequently, a decrease in the valence of positive ions is attributed to the gain of electrons. In negative ions, there is a greater number of electrons than protons, and a decrease in negative valence is attributed to the loss of electrons. In the case of non-polar valence, the gain or loss of electrons cannot be so definitely ascribed to any specific atom concerned in the process. Since, however, there is a gradation between the two extremes of complete transfer and electron sharing, a decrease in positive valence number may be considered to be equivalent to a gain of electrons. There is much of a speculative nature in the application of our ideas of atomic structure to the complex question of valence. As the scientific interpretation of the nature of the changes involved in electron sharing becomes clearer in the light of work yet to be done, a broader understanding of the nature of oxidation-reduction will be acquired.

Oxidation-Reduction

Oxidation is an increase in the numerical value of the positive valence or a decrease in the negative valence. Reduction is the opposite process. Increase in positive valence is due to the loss of electrons and decrease in positive valence to the gain of electrons. During reactions in which one substance oxidizes another, a transfer of electrons occurs. The processes of oxidation and reduction are, consequently, simultaneous processes.

Oxidation-reduction may be defined as a process in which the substance reduced gains electrons from the substance which is oxidized.

Representation of Oxidation-Reduction.—Several schemes have been advocated for making use of the electronic concepts in deriving the equations to represent reactions of oxidation-reduction.[3] As pointed out by Hall,[4] these schemes are the outgrowth of the application of the ideas of atomic structure to the valence change method first published by Johnson in 1880 in Douglas & Prescott's, "Qualitative Analysis." The essential difference in these schemes is that in one type the electronic changes are referred to specific atoms contained in the oxidizing and reducing agents, whereas in the other the gain or loss of electrons is represented in terms of the ions which these substances furnish in solution. It is not the purpose of this paper to discuss the relative merits of these schemes, and the reader is referred to the articles mentioned above for the further consideration of the mechanism of applying electronic concepts to the derivation of the equations for oxidation-reduction reactions. These schemes all agree in placing the emphasis on what we now believe to be the fundamental change involved in oxidation-reduction—the electronic phenomena. To the writer, it does not seem to matter greatly which scheme is employed or whether any specific scheme is used, so long as this is made the basis of the discussion. The students' mental picture of the nature of the changes is the important point to keep in mind and this cannot be put into any of these schemes. The verbal discussion of the reaction is far more important than the scheme which is employed for the representation of the reaction.

Oxidation-Reduction Phenomena.—Following this lengthy discussion, which nevertheless seems necessary in order to define the point of view from which this subject is discussed, let us next proceed to the consideration of some specific phenomena which are useful in the presentation of this subject in our classes.

Electrolysis.—A consideration of the changes which occur during electrolysis offers the simplest introduction to oxidation-reduction as an electronic phenomenon. Any one of a number of substances may be chosen for the illustration of this process; but the electrolysis of cadmium iodide is selected, because it is a simple matter to see and identify the products liberated at the electrodes. (Experiment.) The discharge of cadmium ions is due to the gain of electrons (reduction) at the cathode and the discharge of iodide ions to the loss of electrons (oxidation) at the anode.

[3] Stuart R. Brinkley, THIS JOURNAL, **2,** 576 (July, 1925); D. T. Keach, "The Electron in Oxidation-Reduction," Ginn & Co., **1926;** H. L. Lochte, THIS JOURNAL, **4,** 273 (Mar., 1927); E. R. Jette and V. K. LaMer, Ibid., **4,** 1021 and 1158 (1927); E. R. Jette, "Oxidation-Reduction Reactions," The Century Co., **1927.**

[4] W. T. Hall, THIS JOURNAL, **6,** 479 (Mar., 1929).

$$Cd^{++} + 2\epsilon \longrightarrow Cd, \qquad 2\,I^- - 2\epsilon \longrightarrow I_2$$

In the case of solutions of salts of active metals, hydrogen ions are reduced at the cathode, because of the fact that they are discharged at a lower potential than the ions of the active metals. Faraday's law will now take on a real significance to the student. One Faraday, 96,500 coulombs, represents enough electricity to furnish one electron to each of the 6.06×10^{23} ions in one gram ion of the substance. If an ion requires two electrons for its discharge, obviously only one-half as many atoms of the substance can be set free by this amount of electricity, as in the case of those ions which require only one electron for their discharge.

Displacement Reactions.—The consideration of displacement reactions as an electronic phenomenon follows logically. The discharge of a positive ion requires a gain of electrons, whether over a wire or from the atoms of more active metals. (Experiments: zinc with dilute sulfuric acid; copper with silver nitrate solution; chlorine with potassium iodide solution.) In the first two cases, the liberation of the observed product is due to the gain of electrons; and, therefore, does not differ fundamentally from the liberation of cadmium in the electrolysis of cadmium iodide.

$$Zn \longrightarrow Zn^{++} + 2\epsilon, \qquad 2H^+ + 2\epsilon \longrightarrow H_2$$

The liberation of iodine in the third experiment is due to the loss of electrons, in the same manner as during the electrolysis, discussed above, except that the electrons are received by chlorine. Just as in electrolysis, a sufficient difference in potential to cause the transfer of electrons must be established by the proper selection of materials and concentrations. The fact that displacement involves an electrical transfer is easily demonstrated by arranging the materials in the form of a cell, so that electrons are transferred along an outside conductor instead of directly from atom to ion; *i. e.*, the substances must be out of physical contact but must be in electrical contact. Thus, the displacement of copper by zinc is arranged in the well-known Daniell cell (Experiment) so that the flow of electrons takes place through an outside conductor and the difference in potential is registered on a suitable voltmeter.

Direct Union.—Just as the production of elementary substances from compounds by electrolysis and by displacement reactions involves an electron transfer, so reactions of direct union are oxidation-reduction phenomena. When hydrogen unites with chlorine (Experiment) the reaction may be interpreted as accompanied by a transfer of electrons from hydrogen to chlorine. As a consequence, hydrogen is left in the form of monovalent positive ions, and chlorine is converted into monovalent negative ions. Similarly, if a fragment of potassium is introduced into liquid bromine (Experiment) a vigorous reaction ensues, with the formation of potassium bromide.

$$2K \longrightarrow 2K^+ + 2\epsilon, \qquad Br_2 + 2\epsilon \longrightarrow 2Br^-$$

The electrical nature of reactions of direct union may be demonstrated by a cell (Experiment) in which a zinc electrode, placed in a battery jar in a salt solution, is oxidized by chlorine, introduced into a porous cup, within the jar, containing an inert electrode in a salt solution. The tendency for the electrons to flow from the zinc to the chlorine is registered on a voltmeter.

Oxidation-Reduction Involving Compound Substances.—The types of reactions just discussed are simple reactions, in which it is an easy matter to demonstrate the electrical nature of oxidation-reduction. A large number of the valence change reactions, encountered in a course in general chemistry, involve compound substances as oxidizing agents and as reducing agents. In such cases, non-polar valences are involved. A decrease in positive valence number may, however, be considered to be equivalent to the gain of electrons, and the equations may be derived in a similar manner to that employed in the preceding examples, or the ion-electron method of deriving the equation may be used. In the examples which follow, the former method will be employed, because this is the simpler method for the student to follow. In the discussion of such reactions in the classroom, however, the difference in the mechanism of the change should be indicated. In order to avoid repetition, the steps employed in deriving the equations will be shown only in a few typical cases.

These reactions are sometimes carried out in anhydrous media, and at other times in aqueous solutions. A simple reaction illustrating the former case is shown by the ingredients of gunpowder. When gunpowder is heated to start the reaction (Experiment) a rapid combustion results, during which potassium nitrate oxidizes sulfur and carbon. A more satisfactory demonstration consists in melting potassium chlorate in a crucible and adding fragments of carbon, such as charred match sticks (Experiment). Afterward, the residue may be leached with water, and it may be shown by test that the chlorate has been reduced to the chloride.

Frequently, some third substance is added to increase the activity of either the oxidizing agent or the reducing agent. This third significant substance is usually either an acid or a base, depending on the specific nature of the substances involved in the reaction. The products actually obtained in these reactions may be determined by test, if necessary; but often it is possible to deduce the composition of the products from the nature of the reacting substances. This latter procedure furnishes an excellent test of the student's ability to correlate the various different facts which he has learned regarding the behavior of specific classes of substances. In the case of oxidation-reduction involving the presence of a significant medium in which the reaction takes place, we may recognize four distinct classes of reactions.

1. Anhydrous substances fused in basic medium.
2. Anhydrous substances fused in acidic medium.
3. Solution reactions in the presence of an acid.
4. Solution reactions in the presence of a base.

Time does not permit the discussion of all of these cases, but the principles involved may be indicated by the discussion of several reactions of one of these types.

Oxidation-Reduction in Acid Solution.—A number of substances illustrate oxidation-reduction in acid solution; but, because of its inclusion in all courses, nitric acid will be used as an example of an oxidizing agent used in acid solution. There are a number of reduction products of nitric acid. The product obtained in any case will depend on the concentration of the acid and the activity of the reducing agent. Since nitric oxide is the major product of the reduction of nitric acid under the conditions usually employed, further consideration of the subject will be limited to this case. The simultaneous change on the part of the reducing agent may yield several different types of products, depending on the chemical nature of the substance.

Oxidation of Non-Metals in Acid Solution.—Let us approach the conclusion regarding the product obtained in the oxidation of a non-metal in acid solution by a series of experiments. When phosphorus burns in air the product is the oxide, phosphorus pentoxide (Experiment). The addition of water to the pentoxide yields an acid, as shown by the litmus test (Experiment); and it is observed that energy is evolved during this reaction. Hence, the reaction of nitric acid in solution with phosphorus is expected to yield phosphoric acid as the oxidation product of the phosphorus. (Experiment: Reaction of nitric acid with red phosphorus. After a short time, test the clear solution by adding magnesia mixture and ammonium hydroxide, in order to demonstrate the correctness of the conclusion.)

$$H_2O + HNO_3 + P \longrightarrow NO + H_3PO_4 \text{ (Unbalanced)}$$

In the reduction of nitric acid to nitric oxide, the nitrate ion is decomposed and the valence number of nitrogen decreases from 5^+ to 2^+. This change is equivalent to the gain of three electrons.

$$N^{5+} \longrightarrow N^{2+} \text{ (Gain } 3\epsilon)$$

The valence number of phosphorus simultaneously increases from 0 to 5^+, equivalent to the loss of five electrons.

$$P \longrightarrow P^{5+} \text{ (Loss } 5\epsilon)$$

Since the total number of electrons lost by the reducing agent is equal to the total number gained by the oxidizing agent, the molar ratio of the

products, nitric oxide and phosphoric acid, is 5:3; and the balanced equation is:

$$2H_2O + 5HNO_3 + 3P \longrightarrow 5NO + 3H_3PO_4$$

Oxidation of a Metal in Acid Solution.—The oxidation of magnesium by atmospheric oxygen yields the metal oxide, magnesium oxide (Experiment). Magnesium oxide reacts with nitric acid to form the soluble salt, magnesium nitrate (Experiment). Therefore, the only product logically to be expected from the oxidation of magnesium in the presence of an acid is the salt. (Experiment: Oxidize magnesium by the action of nitric acid, and test the solution for the presence of magnesium ions.)

$$3Mg + 8HNO_3 \longrightarrow 3Mg(NO_3)_2 + 2NO + 4H_2O.$$

This type of reaction may easily be arranged in a cell so that its electrical nature can be demonstrated. (Experiment: A zinc rod in a salt solution in a battery jar. Nitric acid in contact with a carbon electrode in a porous cup placed in this solution. Connect through voltmeter.) The pole reactions may be written in the following manner:

$$Zn \longrightarrow Zn^{++} + 2\epsilon$$
$$4H^+ + NO_3^- + 3\epsilon \longrightarrow NO + 2H_2O$$

Hence, the complete reaction in the cell is represented by the equation:

$$3Zn + 8HNO_3 \longrightarrow 3Zn(NO_3)_2 + 2NO + 4H_2O$$

Oxidation of Ions.—The addition of nitric acid to a solution of hydrogen sulfide results in the formation of free sulfur (Experiment); *i. e.*, the oxidation of simple non-metal ions in acid solution usually results in the formation of the free non-metal. The equation for the reaction is easily derived as above.

$$3H_2S + 2HNO_3 \longrightarrow 3S + 2NO + 4H_2O$$

The action of nitric acid on mercurous nitrate results in the formation of mercuric nitrate. (Experiment: To solutions of mercurous and mercuric nitrate, respectively, add sodium hydroxide. The colors of the precipitated oxides will serve as tests for the valence condition of mercury. Now, add nitric acid to a solution of mercurous nitrate; heat; and follow with the addition of sodium hydroxide.) The oxidation of a positive ion of low valence in acid solution yields the positive ion of high valence if any exists.

Effect of Conditions

Manganese Compounds.—Since manganese yields compounds in several different valences, the study of the relation of these compounds to each other furnishes a good example of the effect of conditions and of the criteria upon which one decides what conditions to employ. Divalent manganese is metal-like and yields manganous ions. Hence, this is the

most stable of the valence conditions of manganese in acid solution. In its higher valences, manganese is non-metallic; and, consequently, the oxidation of manganese from lower to higher valences is favored by the presence of a base. The oxidation of manganous compounds in basic solution usually results in the formation of manganese dioxide. (Experiment: To a solution of manganous sulfate, add sodium hydroxide; and, to the resulting suspension of manganous hydroxide, add a basic oxidizing agent, such as sodium hypochlorite.)

$$Mn(OH)_2 + NaClO \longrightarrow MnO_2 + NaCl + H_2O$$

In order to oxidize manganese to the next higher valence condition, hexavalent manganese, basic fusion with an oxidizing agent is chosen. (Experiment: In an iron crucible, place a mixture of manganese dioxide and potassium nitrate. Add a short stick of potassium hydroxide and heat. Pour the melt on a porcelain plate to cool and then dissolve in water.) The formation of the manganate under these conditions is evident from the color of the fused mass and of the solution.

$$MnO_2 + KNO_3 + 2KOH \longrightarrow K_2MnO_4 + KNO_2 + H_2O$$

Manganates are stable in solution but manganic acid is not. Consequently, when the solution of the manganate is acidified, manganic acid undergoes a compensating oxidation-reduction reaction, in which purple permanganic acid and a brown precipitate of manganese dioxide are formed. (Experiment: Add acetic acid to the green solution of the manganate obtained above.)

$$K_2MnO_4 + 2HC_2H_3O_2 \rightleftharpoons H_2MnO_4 + 2KC_2H_3O_2$$
$$3H_2MnO_4 \longrightarrow 2HMnO_4 + MnO_2 + 2H_2O$$

The reduction of compounds containing manganese in the heptavalent condition (permanganates) may be carried out in either basic or acidic solution, since the element yields compounds in a lower non-metallic valence (4^+), and in a lower metallic valence (2^+). When potassium permanganate is reduced in basic solution, manganese dioxide is the reduction product. (Experiment: Add potassium permanganate solution to a freshly prepared solution of sodium stannite, obtaining a precipitate of brown manganese dioxide.)

$$KMnO_4 + Na_2SnO_2 + H_2O \longrightarrow MnO_2 + Na_2SnO_3 + KOH$$
$$Mn^{7+} \longrightarrow Mn^{4+} \quad (\text{Gain } 3\epsilon)$$
$$Sn^{2+} \longrightarrow Sn^{4+} \quad (\text{Loss } 2\epsilon)$$
$$2KMnO_4 + 3Na_2SnO_2 + H_2O \longrightarrow 2MnO_2 + 3Na_2SnO_3 + 2KOH$$

When potassium permanganate is reduced in acid solution, the normal reduction product is a manganous salt, because divalent manganese is the most stable valence under these conditions. (Experiment: To a solution of ferrous sulfate acidified with sulfuric acid, add potassium

permanganate. Loss of color indicates the reduction of the permanganate to the manganous condition. The formation of ferric iron in the solution may be shown by a suitable test.)

$$KMnO_4 + FeSO_4 + H_2SO_4 \longrightarrow MnSO_4 + K_2SO_4 + Fe_2(SO_4)_3 + H_2O$$
$$Mn^{7+} \longrightarrow Mn^{2+} \text{ (Gain } 5\epsilon)$$
$$2Fe^{++} \longrightarrow 2Fe^{+++} \text{ (Loss } 2\epsilon)$$
$$2KMnO_4 + 10FeSO_4 + 8H_2SO_4 \longrightarrow 2MnSO_4 + K_2SO_4 + 5Fe_2(SO_4)_3 + 8H_2O$$

Several additional examples of oxidations by potassium permanganate offer interesting considerations. In acid solution, oxalic acid is oxidized to yield carbon dioxide and the permanganate is reduced to the manganous salt. (Experiment.) Similarly, acid solutions of hydrogen peroxide yield oxygen, when oxidized by potassium permanganate. (Experiment.) Powdered potassium permanganate, saturated with glycerine, reacts so rapidly that the temperature is raised to the kindling temperature of glycerine and it bursts into flame. (Experiment.) Potassium permanganate reacts with concentrated sulfuric acid to form permanganic acid, which yields manganese heptoxide by dehydration. If a stream of illuminating gas is led over this mixture, oxidation occurs with such rapidity that the gas is ignited. (Experiment.)

Chromium Compounds.—The chemistry of the chromium compounds offers a consideration of the same kind of phenomena as those observed in the case of the manganese compounds. The common chromium compounds are those in which it exhibits the valence numbers of 3^+ and 6^+. There are two series of compounds in each of these valences. Due to the amphoteric nature of trivalent chromium, it forms chromic salts in acid solution and metachromites in basic solution. (Experiment.) Hexavalent chromium yields chromates in basic solution and dichromates in acid solution. (Experiment.) The oxidation of trivalent chromium requires a basic medium for the reasons discussed in connection with manganese. (Experiment: To a solution of chromic sulfate, add sodium hydroxide in excess. This results in the formation of sodium metachromite. Now add sodium hypochlorite and boil the solution. The appearance of a yellow solution indicates the formation of sodium chromate.)

$$NaCrO_2 + NaClO + NaOH \longrightarrow Na_2CrO_4 + NaCl + H_2O$$
$$Cl^{1+} \longrightarrow Cl^{1-} \text{ (Gain } 2\epsilon)$$
$$Cr^{3+} \longrightarrow Cr^{6+} \text{ (Loss } 3\epsilon)$$
$$2NaCrO_2 + 3NaClO + 2NaOH \longrightarrow 2Na_2CrO_4 + 3NaCl + H_2O$$

Hexavalent chromium may be reduced to the trivalent condition in either acid solution or basic solution, because trivalent chromium is amphoteric. The reduction in acid solution involves the conversion of the dichromate into the chromic salt. (Experiment: Add stannous chloride to an acid solution of potassium dichromate.)

$$K_2Cr_2O_7 + SnCl_2 + HCl \longrightarrow KCl + CrCl_3 + SnCl_4 + H_2O$$
$$2Cr^{6+} \longrightarrow 2Cr^{3+} \text{ (Gain } 6\epsilon)$$
$$Sn^{2+} \longrightarrow Sn^{4+} \text{ (Loss } 2\epsilon)$$
$$K_2Cr_2O_7 + 3SnCl_2 + 14HCl \longrightarrow 2KCl + 2CrCl_3 + 3SnCl_4 + 7H_2O$$

In basic solution, the reduction involves the conversion of the chromate to the metachromite. This may be accomplished by the action of sodium stannite or of alkaline solutions of sodium sulfite.

An interesting oxidation-reduction within the crystal is shown by ammonium dichromate. When this substance is heated sufficiently to start the reaction, it then spontaneously decomposes, with the formation of chromic oxide, nitrogen, and water. (Experiment: Prepare a pile of pulverized ammonium dichromate, inserting a piece of magnesium ribbon to serve as a fuse. Ignite the magnesium to start the reaction, which then proceeds with the formation of a bulky green powder of chromic oxide). The hexavalent chromium is reduced by the trivalent nitrogen in the ammonium radical.

Summary

In making a fair evaluation of the material presented in this paper, one must consider the fact that the reactions of oxidation-reduction are interwoven into the fabric of the entire course. The presentation discussed involves beginning logically with electrolysis as a simple type of oxidation-reduction. This is followed somewhat later by displacement and direct union reactions as valence change phenomena. The significance of the conditions under which the reaction is carried out is illustrated by a consideration of the reactions of nitric acid, and of many other substances throughout the latter half of the course. The order of the development of the concepts involved in the consideration of oxidation-reduction is such as to employ progressive repetition with increasing complexity of the problems involved, to emphasize the correlation of chemical phenomena, and to inculcate the habit of logical, slightly sustained reasoning on the part of the student.

A CORRECTION

In footnote 12, page 1268, in the July-August number of THIS JOURNAL, under the article, "The History and Present Status of the Jaber Problem," by Julius Ruska, the author of the reference was erroneously listed as *Ernest* Darmstaedter. The name should have been *Ernst*. The date following the name should have read 1877—, as Dr. Ernst Darmstaedter is still living, his uncle Ludwig having died in 1928, the year mentioned in the note.

HIGH-SCHOOL CHEMISTRY DEMONSTRATIONS*

RUFUS D. REED, STATE TEACHERS' COLLEGE, UPPER MONTCLAIR, NEW JERSEY

The value of lecture demonstration in all science work has been tested by several investigators. Their work has been published in educational journals and as dissertations and some have escaped the notice of abstracters of chemical literature. This paper reports the findings of these investigators and presents a list of experiments suitable for lecture demonstration in a high-school course in chemistry.

Why Demonstrate Experiments?

In a series of experiments by W. W. Carpenter[1] it was found that:

> The majority of students in high-school laboratory chemistry classes, taught by the demonstration method succeed as well as when they perform the experiment individually, if success is measured by tests which measure specific information and ability to think in terms of chemistry. The students of medium and lower intelligence seem to profit on a whole a little more from a good demonstration than when they themselves perform the experiments individually. We may assume further that those students who did write up the demonstration experiments with the same care as taken in writing up an experiment performed by themselves, would on the whole profit practically as much by that experiment as they would have profited if they had performed the experiment themselves on condition that the number of experiments performed individually was not too small a number and that success be interpreted as ability to succeed in terms of the tasks as measured by tests. It is consistent to believe, however, that high schools can profitably increase the amount of experimental work presented by demonstrations, thus giving the student the benefit of a larger number of excellently performed manipulations and a wider and more thorough use of the experimental method. The increase in number of demonstrated experiments should be larger than the decrease in number of experiments performed by individuals. Demonstration will succeed in developing thinking in terms of chemistry; it cannot be expected to develop manual skills.

Substantially the same conclusions were reached by Knox[2] and H. A. Cuningham[3] who found

> . . . that in explanations of experiments the demonstration-trained pupils did better than laboratory-trained pupils.

What Will the Lecture Demonstration Not Accomplish?

Horton found[4] from extensive experimentation on ability of pupils to do laboratory work that:

* Presented before the Symposium on "Lecture Experimentation," Division of Chemical Education, at the 77th Meeting of the American Chemical Society, Columbus, Ohio, April 29 to May 3, 1929.

[1] "Administration of High-School Chemistry," p. 44, **1925.** Bureau of Publications, T. C., Columbia University.

[2] *The School Review*, **35,** 385 (1927).

[3] University of Illinois, *Bulletin*, **18,** 105–7 (1920).

[4] "Outcomes of Individual Laboratory Work in Chemistry," p. 20, **1928.** Bureau of Publications, T. C., Columbia University.

The (high-school) pupils trained by the individual laboratory method are actually able to do an experiment in the laboratory better than the pupils trained by demonstration method, both groups having been previously taught this experiment by their respective methods....

Practice in the laboratory results in greater facility in handling apparatus and in doing tasks which call for such handling. Doing other laboratory work was not able to transfer this training at once.

From the experiments of these men one can conclude:

1. For imparting information in high-school chemistry which can be tested by written tests: pupils succeed better by observing the demonstration of the experiment rather than doing the experiment in the laboratory.

2. The demonstration method as a means of teaching a pupil how to assemble apparatus and to do tasks is inferior to the laboratory method of teaching chemistry.

Another thing which apparently is accomplished is to inspire in students a desire to do more work in chemistry. How potent is this factor is an unmeasured quantity.

What Should Be Given in Demonstration?

Horton recommended:[5]

The presenting by demonstration the important phenomena and experimentation of which an understanding is required and on which written tests will be based. The laboratory will be used to give practice in handling apparatus and in attempting to solve problems by supervised but undirected experimentation.

However, one questions the leaving out of too much laboratory work because (1) students will be unfamiliar with the habit of carefully following directions. It is probably axiomatic that chemistry students must learn to follow directions (even if it is cook-book chemistry) if they do much with chemistry. (2) Many pupils like laboratory work and enjoy chemistry because they can do things for themselves.

Technic of Demonstration

The apparatus should be simple and of common materials. Complicated and unfamiliar apparatus would merely confuse the student and distract his attention from the main features of the experiment. Excess apparatus should be removed from the table.

Experiments should be chosen which yield results that are visible from all parts of the room. The reduction of metallic oxides by aluminum is an example of an experiment which gives visible and obvious results. The testing of the solubility of oxygen in water by shaking a tube of oxygen with a little water and noticing the suction on the stopper is a poor lecture

[5] *Loc. cit.*, 103.

experiment. The solubility of ammonia in water is a much better experiment. Any experiment should be tried out previous to class time with some of the materials to be used in class demonstration so as to avoid disconcerting, unexpected results.

The object of the experiment should be clearly and simply stated. After performance of the experiment the pupils should be questioned on the object of the experiment and their observations. Any points not clear to the students should be discussed. The essential points of the experiment should be driven home. Equations for the reactions should be worked out. Applications of the experiment should be discussed.

Coopridge found by test experiments[6] that

> It is better to give oral instructions for demonstration experiments than a typewritten sheet of instructions.

Should Students Write Up the Experiments?

The information retained by classes, one of which wrote up the experiment and the other did not, was measured by giving an unannounced test 24 hours after the experiment was performed. Then the class which had written up the first experiment was given a second experiment, a write-up for which was not required and the class which did not write up the first experiment was given the second experiment and was required to write it up. Both classes were tested again after 24 hours. The results obtained were as follows:

Class A	Median score on test 1 over experiment which was written up	8.53
Class B	Median score on test 1 over experiment which was not written up	7.20
Class A	Median score on test 2 over experiment which was not written up	8.42
Class B	Median score on test 2 over experiment which was written up	12.88
	...	
Sum of median scores on both tests over experiments which were written up		21.41
Sum of median scores on both tests over experiments which were not written up		15.62
	...	
Difference in median scores		5.79

These results indicated that the median score on tests over experiments which were written up was 37 per cent higher than the median score on experiments which were not written up.

Experiments Recommended for Demonstration

Accepting Horton's criteria:

1. Demonstrate in high-school chemistry those experiments which explain important chemical phenomena and laws.

2. Perform individually experiments which give practice in handling apparatus. The Chemistry Teachers of Northeastern Ohio recom-

[6] *Sch. Sci. Math.*, **23**, 526 (1922).

mend the following list of experiments to be given as separate demonstrations or as supplemental to individual laboratory experiments. This list is somewhat similar to the list of lecture demonstration topics given in the Report of Committee on Order of Procedure of Laboratory and Recitation in High-School Chemistry.[7] It gives specific experiments rather than topics as given by the committee. It does not purport to be all inclusive and doubtless no one teacher would perform all the demonstrations.

A. COMPLETE DEMONSTRATIONS

1. To determine the weight of one liter of oxygen.
2. To determine the amount of a metal which will set free one gram of hydrogen.
3. Boyle's Law.
4. Charles' Law.
5. Conductivity of acids, bases, and salts.
6. Supersaturated solution and crystal growth.
7. Destructive distillation of coal or wood.
8. Preparation and properties of ammonia including ammonia fountain.
9. Preparation and properties of hydrochloric acid.
10. Preparation and properties of chlorine.
11. Preparation and properties of carbon monoxide.
12. Etching with hydrofluoric acid.
13. Phosphorus and its acids, burning of phosphorus and observation of the products.
14. Marsh's test for arsenic.
15. Goldschmidt thermite process or reduction of oxides by aluminum.
16. Operation of carbide lamp.
17. Principle of Davy safety lamp, cooling of flame by wire gauze; extinguishing of candle flame by cool copper spiral.
18. Electrolysis of water, sulfuric acid, sodium chloride solution.
19. Action of steam on hot iron.
20. Hydrolysis of bismuth and antimony salts. Hydrolysis of sodium carbonate, etc.
21. Preparation of hydrogen sulfide, precipitation of metals from solution.
22. Mass action effect. Sodium acetate on ionization of acetic acid.
23. Distillation with Liebig condenser.
24. Preparation of colloids, dialysis, Brownian movement, Tyndall effect.
25. Formula of copper oxide.
26. Copper plating.
27. Digestion of starch by pancreatin and diastase.
28. Babcock milk test.
29. Preparation of alcohol by fermentation.
30. Preparation of nitrobenzene, test for aniline.

B. DEMONSTRATION SUPPLEMENTAL TO INDIVIDUAL LABORATORY WORK

a. Supplemental to oxygen experiment.

1. Preparation of oxygen from mercuric oxide.
2. Testing MnO_2, etc., for ability to give off oxygen.
3. Things increase in weight on burning.

b. Supplemental to hydrogen.

4. Burning of hydrogen.
5. Reduction of copper oxide by hydrogen.
6. Action of sodium, potassium, magnesium, etc., on water.

c. Physical and chemical changes.

[7] THIS JOURNAL, **5**, 1304–5 (Oct., 1928).

7. Iron and sulfur heated continue to glow.

d. Carbon.

8. Reduction of copper oxide by carbon

e. Replacement of metals.

9. Formation of lead tree.

f. Nitric acid.

10. Preparation of nitric acid.
11. Preparation and properties of oxides of nitrogen.

g. Halogen elements.

12. White iodine.
13. Action of sulfuric acid on bromides and iodides.
14. Preparation of bromine.
15. Action of chlorine on bromides and iodides.

h. Compounds of sodium.

16. Solvay process of preparing sodium hydrogen carbonate.
17. Effect of heating sodium hydrogen carbonate.

i. Flame tests.

18. Use of spectroscope.
19. Flares with barium and strontium.

j. Bead tests for metals.

20. Coloring of glass by the use of cobalt.

k. Compounds of calcium family.

21. Heat evolved by adding water to calcium oxide.
22. Bleaching cloth with bleaching powder.

l. Sulfur.

23. Bleaching with sulfur dioxide.
24. Preparation of sulfur dioxide by sulfuric acid on copper.
25. Preparation of sulfuric acid.
26. Action of sulfuric acid on sugar and on wood.

m. Zinc.

27. Galvanizing.

n. Iron.

28. Tempering of iron.
29. Etching of iron.
30. Removal of iron rust stains.

Tin Discovery in British Columbia. Considerable interest has been aroused by the discovery of stannite, a tin-bearing mineral, in a vein in the Snowflake deposit situated in the Revelstoke district of British Columbia. After making a brief examination of this property, in company with the consulting engineer of the Snowflake Mining Co., Dr. V. Dolmage, of the Geological Survey, Dominion Department of Mines, reports that the vein in which the stannite occurs is one of a number of large and persistent parallel quartz veins which can be traced for several miles along the steep mountain sides of this rugged district. It outcrops at elevations of 5500 to 6000 feet six miles north of a point on the main line of the Canadian Pacific railway twenty miles east of Revelstoke. The veins occur in black, highly carbonaceous, in places graphitic, argillites. These are part of a thick series of quartzites, greenstones, argillites, and limestones which occupy almost this entire region, and are part of a still larger group of metamorphosed rocks widely distributed in British Columbia and considered to be of Pre-Cambrian age. The sediments are intruded by granitic rocks, and it is thought that these may have been the source of the solutions from which the minerals were deposited. In No. 1 vein on the Snowflake property, stannite is present in almost all the exposed parts of the vein where other sulfides such as pyrite, galena, and zinc-blende are present, and in the newest workings extending from the long low-level tunnel it is very abundant. In a raise where the vein is four to seven feet wide the tin-bearing mineral is more abundant than any of the other sulfides except pyrite, and, in places, it appears to constitute as much as 10 per cent of the vein. In their composition and geological associations, the veins closely resemble those of Potosi, Bolivia. Both are in old slates or argillites associated with comparatively young granodiorites and granites, and the minerals found in one are almost the same as those found in the other.—*Chem. Age*, **21**, 174 (Aug. 24, 1929).

LECTURE DEMONSTRATIONS IN ANALYTICAL CHEMISTRY*

I. M. KOLTHOFF, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINNESOTA

The elementary education in any subject requires in the first place the teaching of facts. If the student has an inquiring mind the mere knowledge of facts may not interest or satisfy him, but, as a rule, he has to acquire them.

The success of a course to a great extent depends upon the way in which the material is presented. For example, if one teaches a child geography and geology, you can show him on the map the geographical conditions of a country, tell him about the population, economic conditions, imports and exports, but what a dead knowledge if the facts are offered without trying to appeal to his imagination! The student is likely to forget all the facts unless you try to tell him in a more lively way and show him by pictures how life and nature are in the different countries. He observes the facts and they will stick in his mind. Now let us consider the education in chemistry. The situation is somewhat different, because we are not satisfied by only observing facts; we want to interpret them.

The highest achievement of a course is not that the student acquires a certain knowledge in a short time, but the success will depend upon his understanding of facts, their internal correlation and interpretation. From this point of view lecture experiments may have a great educational value, especially for the mediocre students, and I suppose we agree that the great majority belongs to this group. As a rule a student has a tendency to write down as much as possible of what the instructor says and he will study his notes in the same way as he does his work in English, history, etc. Simple, successful, practical demonstrations will impress him in different ways. What first was considered as a vague theory suddenly lives before his eyes; it will stimulate his desire to understand the nature of things and implant facts in his mind.

If we consider more particularly the significance of lecture experiments for a course in quantitative inorganic chemistry, we have to keep in mind that the teaching is more or less an introduction to the practical work. If the latter is carefully selected, it may be questioned whether lecture experiments do not lose their significance, because the student has an opportunity to apply his knowledge in the laboratory himself. Still I believe that the demonstration of a few simple lecture experiments in connection with the description of facts or the understanding of some theoretical fundamentals is not only very useful, but necessary to the success of the course. Therefore, I have selected a few demonstration experiments in the field of gravimetric and volumetric analyses.

* Presented before the Symposium on "Lecture Experimentation," Division of Chemical Education, at the 77th Meeting of the American Chemical Society, Columbus, Ohio, April 29 to May 3, 1929.

General Quantitative Analysis

1. Loss of Liquid by Entrainment in a Gas Evolution.—Moisten a filter paper with potassium ferrocyanide solution and lay it on a glass plate. Place a small beaker on it containing from one to two grams calcium carbonate and a few cubic centimeters of a solution of ferric chloride. Add to this mixture about 20 cc. of 4 to 6 *N* hydrochloric acid. The filter paper is soon covered with blue spots.

2. A Flame from a Bunsen Gas Burner Contains Sulfur Trioxide.—Place one gram of pure sodium chloride in a porcelain crucible and heat it for 45 to 60 minutes over a full Bunsen flame. After cooling dissolve the salt in water and show the presence of sulfate. Moreover, it can be shown that by placing the crucible in a close fitting hole of an asbestos plate, the content is protected from the combustion gases.

3. Washing of a Filter.—Moisten a filter paper with potassium dichromate and wash with water, until the wash water does not give a test for dichromate when treated with sulfuric acid and hydrogen peroxide in the presence of ether. Take the filter paper from the funnel, open it, and show some yellow spots. Then transfer it to a porcelain dish and add a little sulfuric acid, ether, and hydrogen peroxide. A blue color shows that dichromate is still present. If the washing is continued, until the filtrate does not react with sulfuric acid and diphenyl carbazide, it can be shown that it takes a long time until all of the dichromate is washed out (quantitatively). If the test for dichromate in the filtrate is negative or very weak, the presence of dichromate on the filter can still be shown by the diphenyl carbazide test.

4. Solubility Product.—Shake some freshly prepared lead iodide with water, until the solution is nearly saturated and filter. Divide filtrate into two parts. To one part add some lead nitrate solution. To the other part add some potassium iodide solution. In both cases a precipitate of lead iodide appears.

5. Colloidal Nature of Some Precipitates.—Add a small excess of potassium chromate solution to about 0.01 *N* lead nitrate and divide the yellow suspension into two parts.

(*a*) Add to one part a few drops of an aluminum chloride solution. The flocculation is immediately observed. (Compare with the original solution.)

(*b*) Filter the original solution; the filtrate is cloudy. Filter the solution containing the aluminum salt; the filtrate is clear.

Volumetric Analysis—Acidimetry, Alkalimetry, and Indicators

6. Color Change Interval of an Indicator: *e. g.*, Phenol red with Buffers of pH from 6.8–8.0.—If there are two glass wedges of equal size

available, one may be filled with acid indicator solution, the other with an alkaline solution containing the same concentration of indicator. By placing the two wedges upon each other the transition colors can be observed, and the principle of the measurement of pH with di-color indicators without the use of buffer solutions can be demonstrated.

7. Classification of Indicators.—Depending upon the ionization constants of the acid or basic dyestuffs, the color change interval may be found in neutral, acid, or alkaline medium. Take some test tubes with the same volume of tapwater in each.

(*a*) To two tubes add some phenolphthalein.

(*b*) To three tubes add some phenol red or neutral red.

(*c*) To two tubes add some methyl orange.

The indicator in *a* is present in the acid form—addition of acid does not change the color; alkali is required to produce a red-violet color. Therefore, the indicator has its color-change interval in alkaline medium. The indicator in *c* is present in the alkaline form; addition of alkali does not change its color. Acid is required to change color to that of the acid form. The color change interval is on the acid side of neutral point. The indicator in *b* has an intermediate color. To one of the tubes add some alkali, to the other some acid. Phenol red has its color-change interval around the neutral point. The author prefers the use of tapwater in this experiment to that of distilled water, because the latter is always acid on account of carbon dioxide and has a pH of 5.7 or less. Tapwater is a buffer system and as a rule has a pH of about 7.5 ± 0.5.

8. Necessary Excess of Reagent.—Demonstration of the titration error and the choice of the proper indicator for different cases. Use high-grade salts and distilled water for these demonstrations.

Neutralization of a strong acid with a strong base. Prepare about one liter of approximately 0.1 *N* sodium chloride. To two beakers each containing 100 cc. of 0.1 *N* sodium chloride add ten drops of a 0.1% solution of methyl orange. Add to one of the two beakers 0.1 to 0.2 cc. of 0.1 *N* hydrochloric acid and observe the difference in color. Repeat, but use methyl red as an indicator. Addition of less than 0.1 cc. of 0.1 *N* acid changes the color completely to that of the acid form. Repeat, but use phenolphthalein as an indicator. Add to one of the two beakers 0.1 cc. of 0.1 *N* sodium hydroxide. A faint, violet color appears. If the solvent contains too much carbon dioxide, the color fades fairly rapidly. The demonstration shows the "jumpwise" change of pH at both sides of the equivalence point in the neutralization of a strong acid with a strong base or vice versa.

Neutralization of weak acid with strong base. Prepare about one liter (approximately) 0.1 *N* sodium acetate. To two beakers each containing 10 cc. of 0.1 *N* sodium acetate, add a few drops of phenolphthalein. As a rule the solution does not change in color. Add to one of the two solutions

0.1 cc. of 0.1 *N* sodium hydroxide. The color turns red-violet. (Compare the test with NaCl.) Instead of using phenolphthalein as an indicator use phenol red. If the water is carbon-dioxide free, the solution will acquire the alkaline color; as a rule, however, an intermediate color of the indicator will be observed. In the latter case addition of 0.1 cc. of 0.1 *N* NaOH to 100 cc., changes the color completely to red. On the other hand addition of 0.1 cc. of 0.1 *N* HCl does not change the color completely to that of acid form; approximately 1 cc. is required. *With methyl red as indicator:* The solution is alkaline to this indicator. Approximately 4 cc. of 0.1 *N* HCl for 100 cc. of 0.1 *N* sodium acetate are required to produce a slight difference in color from the original solution. With more acid the color changes gradually to pink and red. (Color-change interval of methyl red.) A similar experiment can be made with bromocresol green, or methyl orange or bromophenol blue, but here it is better to start with 25 cc. of 0.1 *N* sodium acetate, as much acid is required to cause a change in color.

Neutralization of weak base with strong acid. Prepare about one liter of (approximately) 0.1 *N* ammonium chloride. To two beakers containing 100 cc. of 0.1 *N* ammonium chloride add a few drops methyl red. An intermediate color is observed. Add to one of the solutions 0.1 cc. of 0.1 *N* HCl; the color turns pure red. Add to the other one 0.1 cc. of 0.1 *N* NaOH; the color turns pure yellow. Repeat the experiment, using methyl orange or bromophenol blue as an indicator. The ammonium chloride solution is alkaline to these indicators. The addition of 0.1 to 0.2 cc. of 0.1 *N* HCl causes a distinct color change. Use phenol red as an indicator. The solutions are acid to this indicator. About 1 cc. of 0.1 *N* NaOH is required to change the color of one of the two solutions from yellow to orange-red. Use phenolphthalein as an indicator. More than 5 cc. of 0.1 *N* sodium hydroxide are required to turn the solution a faint pink. With more NaOH the color changes gradually to a deeper red-violet. (Color change interval of phenolphthalein.)

9. Slow Neutralization of Carbon Dioxide to Bicarbonate.—Add a few drops of phenolphthalein to a dilute carbon dioxide solution. Then titrate with 0.1 *N* sodium hydroxide. The red color fades after standing a short time. With a little more sodium hydroxide the red color again appears, but fades on standing. A permanent end-point is obtained after all of the carbon dioxide has been transformed into bicarbonate.

Precipitation Reactions

10. Titration to the Clearpoint.—Titrate 100 cc. of 0.025 *N* potassium iodide with 0.1 *N* silver nitrate carefully. About 1 to 2% before the equivalence point the silver iodide starts to flocculate; the supernatant liquid is milky (cloudy). Continue the titration carefully drop by drop with shaking. At the equivalence point the supernatant liquid is no longer cloudy,

but perfectly clear. This experiment shows, moreover, the colloidal nature of silver iodide and its peptization by iodide ions. In connection with this experiment discuss the precision titration of silver according to Gay-Lussac-Mulder.

11. Silver Thiocyanate Adsorbs Silver Ions.—Titrate 25 cc. of 0.1 *N* silver nitrate according to Volhard with 0.1 *N* thiocyanate, using ferric alum as an indicator. The first color change to pink-brown occurs before the equivalence point is reached (about 0.8%). On shaking, the color disappears again. A permanent end-point is reached at the equivalence point, where all of the adsorbed silver has reacted with the thiocyanate in the solution.

12. Demonstration of Behavior of Adsorption Indicators.—To 25 cc. of approximately 0.025 *N* silver nitrate add a few drops of a 0.1% fluorescein solution. The indicator assumes the same color as in pure water. Add a little 0.1 *N* sodium chloride to the silver solution; the color turns red immediately. With an excess of chloride the color changes again to green-yellow. This experiment shows that the indicator is not sensitive to silver ions in the solution, but reacts in a very delicate way with silver ions adsorbed on the silver chloride lattice.

Oxidation-Reduction Reactions

13. Diphenylamine as Oxidation-Reduction Indicator.—Prepare approximately $^1/_{40}$ *M* potassium ferrocyanide, 1% ferricyanide, $^1/_{20}$ molar zinc sulfate in water and 1% diphenylamine in strong sulfuric acid. To 25 cc. ferrocyanide solution add two drops ferricyanide, 5 cc. of 4 *N* sulfuric acid, and two drops diphenylamine. The indicator does not change the color of the solution. In another beaker add to about 50 cc. of the zinc sulfate solution, 5 cc. of 4 *N* sulfuric acid and one to two drops indicator; the liquid remains colorless. Add the zinc sulfate solution slowly to the ferrocyanide solution. After the complete formation of $K_2Zn_3(Fe(CN)_6)_2$, the color suddenly turns blue-violet. With a little excess ferrocyanide the color disappears again. The color change is reversible. The experiment demonstrates that the indicator is not specific for the reacting ions, but behaves as an oxidation-reduction indicator. The ferrocyanide solution, containing a little ferricyanide does not have an oxidation potential high enough to oxidize the indicator via diphenylbenzidine to the blue quinoid form. By removing the ferrocyanide ions with zinc the oxidation potential increases and at the equivalence point where practically no ferrocyanide ions are left, the oxidation potential is so large that the indicator is transformed into the blue oxidation product. Addition of ferrocyanide again lowers the potential and the color disappears.

14. Influence of Complex Ion Formation on Oxidation Potential.—(*a*) Prepare an approximately 0.1 *M* ferric chloride solution, about 20%

phosphoric acid, 4 *N* hydrochloric acid, and 1 *N* potassium iodide. Take three beakers and add 50 cc. of ferric chloride to each and 2 cc. hydrochloric acid. Add to two of the solutions 20 cc. phosphoric acid. The yellow color disappears due to a complex formation between the ferric ions and phosphoric acid. Add to the original solution and one of the solutions containing phosphoric acid 10 cc. of potassium iodide. The former is colored dark brown from the iodide which is formed in the reaction: $Fe^{+++} + I^- \leftrightarrows Fe^{++} + {}^1/_2 I_2$; the iron solution containing phosphoric acid does not change. As a result of the complex formation, the oxidation potential of the ferric iron solution has decreased so much that the iodide ions are no longer discharged.

(*b*) With regard to the iron titration according to Knop the following experiment is recommended. Take 25 cc. of the ferric chloride solution and add 15 cc. of 4 *N* hydrochloric acid. The solution is yellow. Add a few drops 1% diphenylamine; the color changes to dark, brownish red violet. Add 20 cc. of phosphoric acid; the dark color turns greenish yellow. The oxidation potential of the ferric ions in hydrochloric acid is large enough to oxidize the indicator. Phosphoric acid cuts the potential down.

15. Abnormal Reaction between Iodine and Thiosulfate in Weakly Alkaline Solution.—(*a*) Titrate 25 cc. of 0.1 *N* iodine in a neutral or weakly acid solution with a 0.1 *N* solution of sodium thiosulfate.

(*b*) Add to 25 cc. of 0.1 *N* iodine, one gram of sodium bicarbonate and titrate with 0.1 *N* sodium thiosulfate. The titration number in the latter case is much smaller than in the former. Acidify both solutions after the titration with acetic acid and add a few cubic centimeters of barium chloride; solution *a* remains clear, whereas *b* gives a distinct precipitate of barium sulfate. The fact is often overlooked in the literature that in a weakly alkaline medium iodine oxidizes a part of the thiosulfate to sulfate, which may involve a large error: $S_2O_3^{=} + 4I_2 + 10OH^- \longrightarrow 2SO_4^{=} + 8I^- + 5H_2O$.

Energy from Tropical Oceans? Serious efforts are already being made to develop new sources of energy to which the world may turn when its supplies of coal shall have been greatly diminished. Claude has recently built a turbine which developed 60 kilowatts at 6000 revolutions per minute when driven by water vapor taken from a boiler at room temperature, the vapor being discharged into ice water. This is a difference of temperature between boiler and condenser of only about 32°F. He now proposes to develop energy by drawing heat from the warm surface water of the ocean off the coast of Cuba, putting the vapor through turbines, and using cold water from the depths of the ocean in his condensers.

Though the sponsor of this idea has brought out inventions in which a hundred million dollars have been invested in America alone, engineers have held his latest proposal to be preposterous. To their calculations that frictional losses would be so great that the turbine could not even start, Claude thinks it sufficient to reply with Galileo: "Nevertheless, it moves."—*Ind. Bull.*, Arthur D. Little, Inc., **No. 33** (Sept., 1929).

CHARLES MAYER WETHERILL, 1825–1871. PART V*

EDGAR FAHS SMITH

CHAPTER VI

Chemist of the Smithsonian Institute

Immediately after the termination of his troublesome governmental experience as chemist of the Department of Agriculture, Wetherill was offered an appointment as chemist of the Smithsonian Institution by its Secretary, Joseph Henry. The two men were strongly attracted to each other, and although Henry was nearly thirty years older than his subordinate, there was not the slightest evidence of any disparity of years or of position in the cordiality of their relations.

The laboratory which Wetherill occupied during his two years with the Smithsonian Institution was located in the connecting range between the east wing and the main body of the present brownstone building. As regards location and conveniences of air and light, it was far superior to the dismal room which he had just occupied in the basement of the Patent Office Building.

The Smithsonian Institute, endowed by the English chemist, James Smithson, as "an establishment for the increase and diffusion of knowledge among men," offered Wetherill a wide field for chemical investigations both in the theoretical and practical branches of the science.

Persons desiring to get the views of Wetherill on the speculative side of chemistry will find in the *Smithsonian Institution Report*[18] "A Brief Sketch of the Modern Theory of Chemical Types." It is a popular presentation of early chemical theory, but more especially that of the theory of types. The story is well told. At one point he remarks:

> To bring these phenomena in accord with the former electrochemical theory, we would have to assign to the atom of chlorine a preponderating positive and negative character at the same time, which was deemed inadmissible.

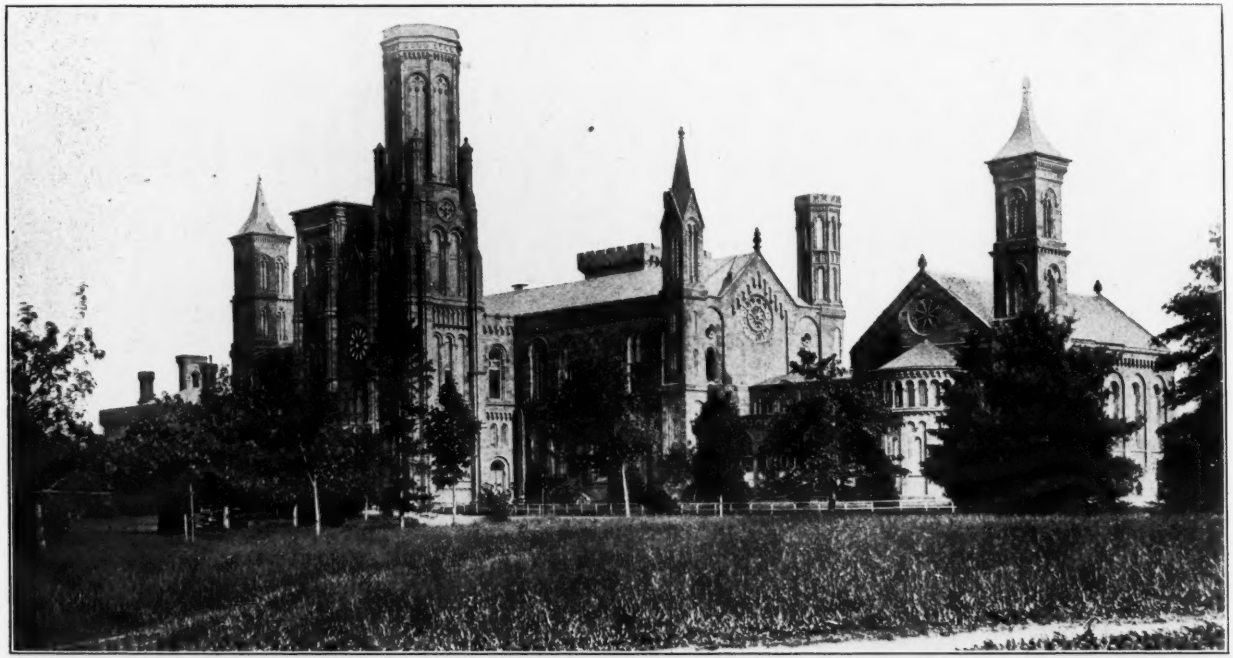
Modern chemists have not hesitated in doing what Wetherill thought was inadmissible and it is refreshing to read the concluding paragraph of the essay, which says:

> Whatever be the faults or merits of the type method, it has, by placing bodies before us in a new relation, suggested experiments (which, perhaps, would not have been otherwise suggested) which have led to important discoveries. At the present time, not to understand this method of reading formulas is to be excluded from following the course of modern chemical progress.

Wetherill claimed to have grown up under the influence of the type theory. He was partial to it and said:

* This is the last manuscript from the pen of the late Edgar Fahs Smith.

[18] P. 153 (1864).



Photograph by courtesy of C. G. Abbot

SMITHSONIAN INSTITUTION ABOUT 1871

The principal change made in the building of the Institution after the destructive fire of 1865, in which Wetherill's laboratory escaped injury, was the addition of a story to the east end.

The type theory met with many supporters, some of them the best thinkers who have enriched modern chemistry. It met with many variations, some of which penetrated far into the realms of fancy, but it would probably have fallen into disuse had not the discovery of the compound ammonias attracted the attention of the chemical world to this method of imagining the constitution of chemical compounds.

A retrospect, such as was given by Wetherill on the type theory, is stimulating and valuable for it must be remembered that in the study of historical chemistry, one encounters many derelicts of the overthrow of theoretical speculations which are wholesome reminders of the efforts of the earliest chemists to solve the problems encountered by them.

In the winter of 1863–64, Wetherill conducted in the laboratory of the Smithsonian Institution some "Experiments with the Ammonium Amalgam," which were published in the *American Journal of Science*.[19] He concluded that the amalgam was not an alloy of mercury and ammonia, but that the swelling of the mass in the phenomenon is due to the retention of gas bubbles and the coherence of the gases and liquids combined is changed from a normal condition, exhibiting phenomena which may be classed with those of catalysis. He continued to think on this subject with the result that he eventually produced the amalgam of methyl ammonium,[20] but this result (published posthumously in 1871), while pretty generally accepted, was opposed by some investigators, so that Wetherill was led to perform numerous experiments with material that had been most carefully purified, and wrote that his results confirmed a previous statement by him that "the compound ammonias may form the so-called amalgams." Subsequent studies of these bodies have confirmed in every way the original work of Wetherill; hence, this contribution is generally looked upon as having high merit.

On January 24, 1865, the upper story of the Smithsonian Institution was visited by a destructive fire and, although Wetherill's laboratory escaped injury, the loss resulting to American chemistry from this conflagration was the most serious ever recorded in the history of our science. All the extensive chemical equipment of Dr. Robert Hare of Philadelphia, consisting of apparatus invented and used by him, was destroyed. The chemical apparatus of James Smithson, a large burning lens used by Joseph Priestley in his experiments upon the production of oxygen from mercuric oxide, and numerous other historic articles of interest to chemists, suffered a similar fate.

Although this fire caused a most serious interruption to the scientific work of the Smithsonian the chemical researches of Wetherill were not seriously affected. An investigation "On the Crystallization of Sulfur and upon the Reaction between Sulfide of Hydrogen, Ammonia, and Alco-

[19] **40,** 160 (Sept., 1865).
[20] *Am. J. Sci.*, 3rd series, **1,** 369 (1871).

hol," continued during 1864 and 1865, was published in the *American Journal of Science*.[21] The article describes several interesting experiments upon methods for producing the various crystalline modifications of sulfur. In the study of the reaction between hydrogen sulfide, ammonia, and alcohol, Wetherill showed that ammonium sulfide was first formed, which then reacted with the alcohol to produce ethyl sulfide.

Another investigation which Wetherill conducted in the laboratory of the Smithsonian Institute was "On the Crystalline Nature of Glass," published in the *American Journal of Science and Arts*.[22] Wetherill subjected fifteen different specimens of glass to the action of hydrofluoric acid and noted upon the etched areas under the microscope needle-shaped crystals which were similar in appearance to those obtained by his teacher Pelouze in the slow cooling of melted glass. From these observations it was inferred that glass "contains crystals already formed, of which some are more soluble in hydrofluoric acid than their matrix, and perhaps others less soluble in the same reagent." Wetherill's research upon glass is one that can still be read with profit, and it reveals in a striking manner the wide range of its author's chemical interests.

The most elaborate research which Wetherill performed during his connection with the Smithsonian Institution related to the warming and ventilating of the National Capitol. This was published as Executive Document No. 100 of the House of Representatives, 39th Congress, 1st Session, with a letter of transmittal from Secretary of the Interior, Jas. Harlan, under the date of May 7, 1866. The purposes of the investigation are indicated in the first paragraph of the introduction by the architect of the U. S. Capitol Extension, Thos. U. Walter.

> During the last session of Congress it was deemed expedient to institute a series of experiments to ascertain by accurate scientific tests the actual results of the means employed for warming and ventilating the United States Capitol Extension; and, in order to render the proposed investigation entirely reliable, and to secure its accomplishment in accordance with the most recent developments of physical science, the aid of Professor Joseph Henry, of the Smithsonian Institution, was obtained, and at his suggestion, Dr. Charles M. Wetherill, an eminent chemist, was employed to conduct the investigations.

Wetherill's report of his chemical investigations upon "Warming and Ventilating the Capitol" comprised 90 pages, with three illustrations of apparatus. The work was conducted with such thoroughness and attention to detail that it ranked for many years as the most authoritative and comprehensive chemical treatise upon the ventilation of public buildings. The subject matter of his investigation consisted of the following main divisions: Introduction; Constitution of the Atmosphere; Analyses and

[21] **40,** 338 (Nov., 1865).
[22] **41,** 16 (Jan., 1866).

Observations at the Capitol; Upon Respiration; The Moisture in the Air; Miscellaneous Substances in the Atmosphere; Ozone.

The system of air replacement installed for ventilating the two chambers of Congress in the Capitol extension admitted 100,000 cubic feet of air into the Hall of Representatives and 60,000 cubic feet into the Senate Chamber per minute. When the ventilating fans were in operation Wetherill found a range of from 3.6 to 5.0 volumes (average 4.5) of carbonic acid per 10,000 volumes of air under different conditions of weather and attendance in the two chambers of Congress. In an extensive comparison of his results with those obtained by European observers Wetherill concluded "that the ventilation of the halls of Congress is far superior to the ventilation of the French Chamber of Deputies or of any other large well-filled apartment in Europe upon which experiments have been recorded."

With regard to ozone, Wetherill's experiments showed that when this constituent was present in the external air it was only very slightly destroyed by contact with the heating coils of the ventilating system, but was almost completely decomposed in the congressional chambers by the organic matters imparted to the air by the audience. Ozone sixty years ago was regarded as composed of negatively charged oxygen atoms, and its removal from the air in certain cases was attributed to a reaction with the so-called antozone which was supposed to consist of positively charged oxygen atoms. Schönbein's theory of antozone, entertained by Wetherill in his report upon "Warming and Ventilating the Capitol" and in his essay upon "Ozone and Antozone," although long ago disproved, is interesting historically for it illustrates how a mistaken conception was used, just as in the case of phlogiston, to explain many chemical phenomena.

The principal criticism which Wetherill made of the Capitol's air supply was its failure to produce an atmosphere of the desired humidity, a common defect of most ventilating systems. Wetherill suggested the use of suitable humidifiers to remedy this condition.

Wetherill's investigations upon the ventilation of the Capitol convinced him of the need of an extensive investigation upon the composition of the atmosphere in different parts of the United States. In the *Smithsonian Report* for 1866,[23] is an article by Wetherill upon this subject with comments by Secretary Joseph Henry. These communications have great value and are best understood by a perusal of them *in extenso*.

A PLAN OF RESEARCH UPON THE ATMOSPHERE

Washington, D. C., July 24, 1865.

Dear Sir:

I beg leave to submit to your consideration the accompanying sketch of a plan for securing the advantages of a research upon the atmosphere in our country, which would

[23] P. 396.

CHARLES M. WETHERILL WITH CHEMICAL APPARATUS EMPLOYED IN HIS INVESTIGATIONS UPON THE VENTILATION OF THE CAPITOL. THE REAGENT BOTTLE IS MARKED

Baryta Water
BaO - HO
Experiments on Ventilation

be not only new, but fruitful of important practical results. The work upon which I was engaged last winter, *viz.*, the ventilation of the Capitol extension, has impressed me with the necessity of this research, and I hope that it will meet your approval.

I am, very respectfully, your obedient servant.

Charles M. Wetherill

Prof. Joseph Henry, Secretary, Smithsonian Institution.

The Need of a Research upon the Proportion of Carbonic Acid (and Oxygen) in the Atmosphere of the United States.

Plants require carbonic acid, animals oxygen, for their existence; hence an accurate determination of these constituents in the atmosphere is of vast importance, and the knowledge gained from such a research is of great value, both from a scientific and a practical point of view. The question has engaged the attention of scientists (in Europe) from the earliest period of modern chemistry, and its discussion has advanced step by step with the improvement of the methods of analysis. Through the labors of Gay-Lussac, Humboldt, de Saussure, Dumas, Boussingault, Lewy, Schlagintweit, and others we are acquainted with the proportion of oxygen and carbonic acid in the atmosphere, and the influence, upon the quantity of these constituents, of day and night, winter and summer, rain and drought, of storms, and of elevation. These results have been obtained for Europe, with the exception of Lewy's experiments in South America, upon an atmosphere subject to disturbances from the carbonic acid emitted from volcanoes.

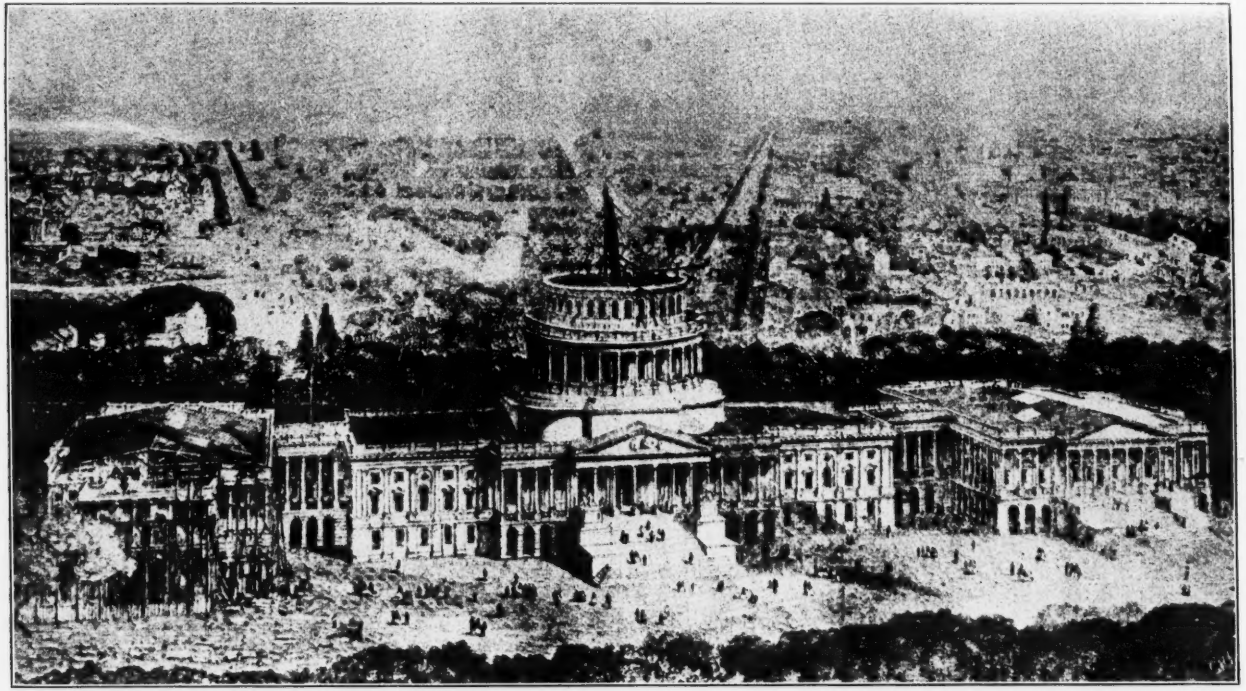
The natural tendency of a dense population and a sparse vegetation would be to increase the carbonic acid and to diminish the oxygen of the atmosphere; hence, the United States, being in this respect different from Europe, it is of importance to know how our atmosphere differs, as to these gases, from the air of the old country. The research has never been made in America for obvious reasons.

Beside the increased knowledge in respect to the nature of the atmosphere which such a research would yield, important practical results would flow from it with regard to ventilation, to the hygiene of cities and of military hospitals, to agriculture and the clearing away of forests, etc.

The examination of the ventilation of the Capitol extension, which has occupied my attention during the past six or seven months, has deeply impressed me with the great importance of experiments upon the atmospheric constituents, and practice in the kind of analyses required has led me to propose to coöperate with the Smithsonian Institution in the accomplishment of such a research.

In this coöperation I will undertake the analysis of specimens of air collected by myself where located, and of such as may be procured by the Institution from different points in the United States, the localities to be settled by the meteorological experience of the Smithsonian Institution. I will bear the expense of analysis myself, in respect to the determination of carbonic acid, and to a less extent of the oxygen. If, however, a large number of oxygen determinations are made, I would be glad if the Institution would furnish me with the apparatus of Regnault or with some other improved one, in order to multiply the observations.

(The investigation proposed by Dr. Wetherill is one of such interest, and as full confidence is placed in his skill as an analytical chemist, and his conscientious accuracy in the statement of the results of his experiments, the assistance required will be furnished by the Institution as soon as the Dr. is prepared to undertake the research. It is probable, however, that he cannot commence the work immediately, since some time will be required to enable him to become familiar with the duties of his new position as professor of chemistry in the Lehigh University.—J. H.)



EAST FRONT OF CAPITOL IN 1861

The dome and the south wing of the building are shown under construction. A study of the warming and ventilating of the Capitol Extension comprised the most elaborate research undertaken by Wetherill.

The two years which were spent by Wetherill at the Smithsonian Institution were a period of happy enterprise which was made all the more enjoyable by the stimulating companionship of Secretary Henry. There are found in Wetherill's letter books many interesting letters from Henry upon family topics, scientific events, and local affairs, all of them most human documents. The following three letters, written in the summers of 1864, 1865, and 1866, not only contain interesting opinions of Henry upon such subjects as the Atlantic cable and tornados but they furnish a pleasing picture of the cordial relations which existed between the Secretary of the Smithsonian Institution and Wetherill.

FIRST SECRETARY OF THE SMITHSONIAN INSTITUTION

Smithsonian Institution
July 15th, 1864.

My dear Professor:

I write to ask whether my family could be accommodated with boarding at the place where you are located or in its vicinity. We would not object to lodging at a good farm house in a pleasant location.

Please inform us as to the price of boarding, the distance, the cost of transportation and any other facts which you may think of importance in making up our decision.

We have been in a state of considerable excitement since you left the city but are now settling down again into our usual stable condition.

Had the attack been made a few days earlier with the full force at the command of the enemy, the city could easily have been taken. It could not, however, have been held without a large army.

Mr. Rhees has this morning visited the field of battle and reports the destruction of property as very large.

I am to go out this afternoon with Mary and Caroline. Before today the roads have been stopped with sentinels.

With kind regards to Mrs. Wetherill, I remain

Very truly yours,

Joseph Henry

Professor Wetherill.

Smithsonian Institution
August 22nd, 1865.

My Dear Dr.:

All things at the Institution are going on as usual. I am still at the table near the window where you left me on your departure. For the last two weeks we have had quite comfortable weather and I have been quite well. Today and yesterday, however, indicate that we are again entering on another hot term.

I hope to get off with my family about the beginning of next month. I found so many questions to be decided in regard to the building that I could not assume the responsibility of leaving until the work was fully underway. But I could not have gotten away had I been so minded. About two weeks ago my daughter Mary met with an accident which at first sight appeared serious. She was shutting the door of a clothes press when the jar brought down a plaster cast of the head of Washington which was standing on the top and cut her temple and broke in one of the side bones of her nose. Fortunately a surgeon from the Armory Hospital was soon in attendance and relieved us from apprehension as to the character of the wounds. She is still confined to her room but is expected to be able to travel in the course of a week or ten days. The physician assured us that she will not be marked with a scar.

I received a note addressed to you from Mr. Grinnell of the Agricultural Department accompanying a copy of Mulder's "Vegetable and Animal Physiology" which had your name stamped on the title page and which had been found in the office of the Department. I addressed Mr. G. a note to say that there could be no doubt that the book belonged to you and that I would put it in the small room in which your library was deposited.

I have heard nothing since your departure as to the change in the agricultural bureau except what was said to me by the member who has charge of the monthly bulletins. He said that Newton had seen the President and was sure of his place though Mr. Kennedy had made an effort to obtain it. Kennedy I think has given up the hope of ousting Newton and now thinks of going to New York to take charge of the business of the American Telegraph Company.

Mr. Clark, the architect employed by the War Department, has been appointed to the charge of the Capitol extension and therefore Mr. Walter will not return to the city.

I learn that Mr. Schaeffer is an applicant for the office of librarian in the Patent Office in place of Mr. Tilson, who goes to Boston to take charge of the city library. I hope Schaeffer will succeed, since I think he will make an excellent librarian and that his knowledge of the contents of books will be of great value to the examiners. I have heard nothing new which is not in the newspapers of the day. The breaking of the telegraphic cable is a very sad disappointment. I expected to have a message from England before this time, since I was promised one as soon as the cable was in working order. I entertain some hope that the end of the long conductor will yet be fished up and the remainder of the putting down completed. I fear, however, that the Atlantic cable will never be a very profitable investment since as it appears to me the outer iron wire which gives the strength to the cable must in time be corroded away, and then any part of the conductor which extends across a hollow and does not touch the bottom will break by its own weight. On the whole, I think the plan of the line over Behring's Straits offers the best chance of continued success. Give my kind regards to your good wife and receive for yourself the assurance

That I am very truly your friend *Joseph Henry*

Mr. Charles M. Wetherill,
Lafayette, Indiana

Smithsonian Institution
Aug. 30th, 1866.

My dear Dr.:

On my return to Washington from the meeting of the American Academy, I found your letter with a large number of others awaiting my arrival; but as all the assistants have been absent and are still so, except Mr. Force, I have not had an opportunity to give your communication attention until this evening.

I am very much obliged for this very interesting account of a phenomenon which few have ever witnessed and fewer still have described, namely, the appearance of a tornado at a distance.

I obtained an account of a similar appearance from an eye witness a few years ago, which was unfortunately lost in the fire, but which I hope to have reproduced as soon as I can have an opportunity of spending an hour or two with the person who furnished me with the statement. He described the commotion in the clouds as a violent upward motion which took place immediately before him as he stood on the crest of a mountain on a level with the middle of the cloud.

The points of special interest in your account are the small elevation to which the agitation extended, that the cloud grew blacker and denser as the commotion continued, the perpendicularity of the motion and the spiral upward wreaths which were observed.

Was the commotion of equal intensity throughout the whole horizontal extent of the cloud; or was it more intense in the middle of the space? Was there any appearance of rain falling between the lower surface of the cloud and the earth as indicated by faint streaks? I am not sure that the tornado which you saw was the same which destroyed the bridge at Havre de Grace. It would appear from the accounts we have received from the newspapers and from the registers of our observers that in the afternoon of the occurrence of the tornado the atmosphere over a considerable portion of Pennsylvania, Maryland, and the eastern states was in a condition of unstable equilibrium; while at the surface there rested a stratum of abnormally moist and warm air, immediately above it was blowing a stratum of dense cold atmosphere; that at different points there were uprushing columns of the warm lower stratum, through the upper and colder, and by the condensation of the vapour giving rise to the phenomenon such as you witnessed. I cannot adopt the hypothesis of conflicting currents of wind as the cause of the tornado. The force in operation acts in a vertical direction and is far too powerful to be the result of ordinary winds from opposite directions. The tremendous force exhibited is readily accounted for on the principle I have adopted by reference to the effect produced by the acceleration of the ball of a blow-gun by the continued pressure of the breath through the length of the tube. The fitful character of the wind and the singling out, as it were, of objects on which to exert its volume, leaving others equally exposed untouched, can also be explained by the fact which I have shown, that air tends to move through air in narrow streams and consequently that obstructions in the course of a broad current would separate it into parallel streams with intervening spaces of quiescent fluid. That the unstable condition of the atmosphere extended over a large space is evident from the fact that hail storms took place in several places in New England on the same evening and that the inhabitants of this city were at the same time viewing with astonishment and admiration one of the most interesting displays of lightning ever witnessed by the oldest beholder. In the direction of about north by east was a very high cumulus cloud about 35° in elevation and 40° in horizontal extent, through which were almost continuously pulsing, for about three hours (from $^1/_2$ past 6 until $^1/_2$ past nine) brilliant discharges of lightning of all forms and in all directions, the greater number being vertical. No thunder was heard although the storm was less than 30 miles distant as was ascertained on the arrival of cars which passed through it this

side of Baltimore. I suppose these discharges were due to the induced electricity on the uprushing columns of moist air and rain which constituted the essential elements of the storm.

We have collected a large amount of information in regard to tornadoes and I have now a person engaged in making drawings and collecting facts in regard to the subject to be incorporated in a memoir for our "Contributions to Knowledge." I am anxious to obtain information as to all the tornadoes which have occurred of late years and especially to ascertain the direction of the path they followed which can in many cases be determined, even after the lapse of many years, by the devastation produced.

I send you a copy of a set of queries I prepared a few years ago relative to tornadoes, and also a copy of my last report to the Board of Regents. I leave with my family for the north about the middle of next week and shall spend a couple of weeks at Sandy Hook experimenting on fog signals. The meeting of the Academy was quite interesting; a number of valuable papers were read. Give my kind remembrances to Mrs. Wetherill and tell her I hope to live to congratulate her on the brilliant success of her son in the line of chemistry.

Truly your friend,

Mr. Wetherill. *Joseph Henry*

Educational Motion Picture Survey Being Made by Department of Commerce. The Industrial and Educational Section of the Motion Picture Division has just sent out a questionnaire on the general subject of motion pictures in education directed to the superintendents of all schools of every kind in the cities and towns of the United States. This questionnaire which was prepared with the coöperation of the Bureau of Education and specifically endorsed by the Commissioner of Education in a cover letter is divided into two main sections, the one to be answered by the superintendent of schools himself, and the other by the teacher in actual charge of classes using motion pictures in school work. A short supplementary questionnaire for the projectionist has been added.

The questionnaire to the superintendent of schools seeks to develop information as to the extent and type of use of motion pictures in schools both in curricular and extra-curricular activities, the organization of the visual instruction unit in the school itself, from what sources and the manner in which films are secured, the number of projection machines in use and other questions designed to indicate the distribution potentialities of the educational field.

The questionnaire directed to the teacher seeks especially to find out the advantages on the one hand which the use of motion pictures contributes to classroom work and on the other hand the difficulties which must be overcome to make these of maximum utility. Other questions along this line will, it is hoped, lead to a knowledge of just what type of material should be put into educational pictures to make them most adaptable for use in schools.

As soon as the necessary replies are received a pamphlet will be published which should give a condensed survey of the views of many educators who are interested in the field of visual instruction. A pamphlet of this kind should be of great value not only to producers and distributors of educational pictures by assisting them to make subjects which will more accurately fit into the school curriculum, but will contribute to the cause of education by showing authentically the results being accomplished by the use of this medium. The value and effectiveness of this pamphlet will be exactly in proportion to the quantity and the specific character of the replies received and it is hoped that as full a response even at the cost of considerable time and trouble will be forthcoming.

INCREASING THE USEFULNESS OF THE SHORT FOCUS PROJECTION LANTERN. PART II*

ROBERT TAFT, UNIVERSITY OF KANSAS, LAWRENCE, KANSAS

Students in advanced classes frequently desire copies of data or diagrams presented by the teacher through the use of lantern slides. Some tables of data are too extensive or diagrams too complicated to allow of making a satisfactory copy in the interval in which the image is shown upon the screen. Of course, references to the literature could be given, but considerable time can be spent in copying these data already photographed. The writer has tried out the plan of using the lecture lantern as an enlarging device for such data, enlarging generally being necessary as contact prints are so small as to be difficultly legible. The results proved so satisfactory and apparently have been of such interest to a number of teachers with whom the writer has talked that a description of the process seems to be worthwhile for those who are not familiar with ordinary photographic processes. It should be pointed out, however, that the use of the lecture lantern as an enlarging device is by no means new.[1]

Elaborate equipment for enlarging is not necessary. The writer's equipment consists of Model *B* Balopticon (Bausch and Lomb) fitted with $4^3/_{16}$-inch equivalent focus lens, 500-watt bulb as illuminant, and a printing frame. The enlarging consists in placing a printing frame (8″ × 10″ usually, as this size fits well into students' notes) containing the sensitized paper in front of the lantern, the image of the lantern slide or its negative (see below) having been previously correctly focused on white paper in the printing frame. Best results are obtained in a darkened room, although with slow papers absolute darkness is not essential. For the insurance bromide mentioned later it is necessary to make the room quite dark. If suitable means for darkening the room are not available, the work may be done at night.

The correct position of the printing frame having been obtained, it is marked with chalk. If working in a darkened room, a small flashlight, the lens of which has been covered with red post-office paper (or painted red) has been found quite useful in locating the mark. Proper exposure is made and the print developed in the usual way. If only two or three copies are desired, prints on the ordinary grades of photographic papers may be made, but if a larger number are wanted, the following procedure may be adopted.

Eastman insurance bromide, Grade *A* (light weight) was used as the

* Read by title, St. Louis meeting, A. C. S., April, 1928.

[1] See, for example, Hepworth, "Book of the Lantern," E. Wilson & Co., New York, 1890.

sensitive paper. This was developed using Crabtree's contrast developer as follows:

1.	Sodium bisulfite	25 gm.
	Hydroquinone	25 gm.
	Potassium bromide	25 gm.
	Water to make	1000 cc.
2.	Caustic soda	45 gm.
	Water to make	1000 cc.

To use take equal volumes of I and II and dilute with six volumes of water. This should be used at temperatures of 21 to 24°C., the time of development being around 3 to 4 minutes. An acid stop bath and fixer are used such as are given in the manufacturer's leaflets found in any package of photographic papers. Care must be taken in the exposures used with the insurance bromide, as it is a very fast paper and reverses (*i. e.*, areas that should be dark are light and vice versa) quite easily, as can be seen from the data tabulated at the end of this paper.

As this paper is quite thin, the dried print may be used as a negative to make contact prints either by silver or blue-print process. Blue-prints are much cheaper and easier to produce. While it will be found that the enlarged print is transparent enough to pass sufficient light for printing, greater transparency may be secured by painting its reverse side with a solution of 1 part paraffin and 4 parts kerosene, or 1 part castor oil and 4 parts alcohol. The print should be dried between blotters or by heat before use. If a more permanent enlarged negative is desired, 8″ × 10″ plates may be substituted for the insurance bromide paper. As even slow plates are somewhat faster than this paper, it may be found necessary to reduce the illumination by the use of filters over the lens to prevent overexposing the plate.

Blue-Prints.—This process consists in placing the enlarged positive in the frame and placing the sensitized surface of the blue-print paper in contact with the enlargement and exposing to the sun for several minutes. Development consists in washing in several changes of water and then drying between blotters. Somewhat greater sharpness in contact prints can be obtained by placing emulsion side in, *i. e.*, next to sensitive surface of the blue-print paper. In order to do this, the image in projection should be reversed, right to left.

Silver Process.—For the silver process much the same procedure can be used, the blue-print paper being replaced by ordinary photographic paper. Better grades of paper make nicer prints and are more easily handled by the beginner than the insurance bromide. Among the satisfactory papers of lowest cost that have been tried are Azo grade *F4;* Haloid Outline special, hard; and Defender Craftsman, contrast. These can be

obtained from most photographic dealers, or from Burke and James, Chicago.

Cost and Time.—To make a single enlargement on insurance bromide and twelve blue-prints (8″ × 10″) will cost for materials (paper and photographic chemicals) in the neighborhood of one and a half to two cents a copy (figured at retail prices). If twelve enlargements are made on the better grades of paper mentioned above, the cost will be in the neighborhood of four to five cents a copy for this size, depending upon the quantity in which the paper is bought. Students can do the work themselves as the process is simple. A pair of students can make an enlargement and twelve blue-print copies in the course of an hour, exclusive of the time of drying, without extending themselves.

Use of Positive and Negative.—As is well known, lantern slides are made by photographing the object it is desired to reproduce, thus producing the negative. From the negative, a positive (the lantern slide) is made by contact exposure or by rephotographing the negative. For enlarging work either positive or negative can be used. A very much smaller exposure is required with positives as the amount of light reaching the sensitive paper is enormously greater. This, of course, assumes that the negatives are of the same dimensions (or nearly so) as the positive. The writer uses an instrument taking $3^1/_4$″ × $4^1/_4$″ plates for making negatives. As lantern slides are $3^1/_4$″ by 4″, those negatives will not fit the ordinary slide holder. The difficulty was obviated by removing the sliding frame in an ordinary slide holder and fitting the remaining frame with two tracks. These were made of small lengths of wood and slotted to take the plate.

In making but one or two direct enlargements, negatives will be found more satisfactory with insurance bromide as photographic reversal is less liable to occur than if a positive is enlarged. Positives, *i. e.*, ordinary lantern slides, may be used with other types of paper, very good results being obtained with the Haloid Outline special (*cf.* Table I.)

Focal Length of Lens.—The small focal lengths (*i. e.*, 4″ to 6″ *EF*) are better as the depth of field in sharp focus is greater, *i. e.*, the position of the printing frame with respect to the lantern does not have to be so accurately adjusted as with longer focal lengths; also much shorter working distances between lantern and printing frame are necessary. The writer has used a 10″ *EF* lens but the results were not nearly as satisfactory as with the shorter focal length.

Direct Copying with Projection Lantern.—The writer has felt the need for a cheap copying device as the commercial copying instruments, photostat, etc., are quite expensive. The lecture lanterns containing opaque projectors offered a possibility along this line for copying data and diagrams of size not greater than 5″ × 5″, the size of the opening for the object in the available opaque projector (not the Model *B* Baloptican pre-

TABLE I

ILLUSTRATING CONDITIONS NECESSARY IN OBTAINING ENLARGEMENTS

Focal length of lens (*EF*)	Distance, slide to lens, inches	Distance, lens to paper, inches	Approx. size enlargement	Exposure, seconds	Slide enlarged, positive or negative	Paper used	Developer	Print* positive or negative
10	13	40	8 × 10	38	Neg.	Azo	Eastman MQ	Pos.
10	13	37	8 × 10	2	Pos.	Azo	Eastman MQ	Neg.
$4^3/_{16}$	6	$16^1/_2$	8 × 10	40	Neg.	Azo	Eastman MQ	Pos.
$4^3/_{16}$	6	$16^1/_2$	8 × 10	30	Neg.	Outline special	Eastman MQ	Pos.
$4^3/_{16}$	6	$16^1/_2$	8 × 10	2	Neg.	Outline special	Eastman MQ	Pos.
$4^3/_{16}$	$10^1/_2$	$6^1/_2$	$1^3/_4 \times 2^1/_2$	3	Neg.	Insurance bromide	Crabtree	Pos.
$4^3/_{16}$	$10^1/_2$	$6^1/_2$	$1^3/_4 \times 2^1/_2$	3	Pos.	Insurance bromide	Crabtree	Pos.
$4^3/_{16}$	$10^1/_2$	$6^1/_2$	$1^3/_4 \times 2^1/_2$	1	Pos.	Insurance bromide	Crabtree	Neg.
$4^3/_{16}$	$5^1/_2$	$27^1/_2$	11 × 16	3	Neg.	Insurance bromide	Crabtree	Pos.
$4^3/_{16}$	6	18	8 × 10	3	Neg.	Insurance bromide	Crabtree	Pos.
$4^3/_{16}$	6	18	8 × 10	30	Neg.	Insurance bromide	Crabtree	Neg.

* Positive or negative print means positive or negative with respect to slide enlarged. Thus if no reversal occurs an enlarged positive will give a negative, and an enlarged negative, a positive print. These results are included to show behavior of the insurance bromide.

viously mentioned). The instrument used reversed the image right to left as projected on paper so a mirror was used to reverse the image by changing the line of projection through an angle of 90°. On slow photographic papers an object could be obtained but it was not sharply defined and the contrast was not great. Possibly by the use of more powerful illumination and shorter focal length lenses this could be satisfactorily accomplished. Manufacturers of projection devices would do well to give this their attention as a fairly cheap copying device would be exceedingly convenient for the teacher.

E. P. Jones[2] has offered a suggestion for copying photographs and drawings similar to that used by the writer in making copies of his enlargements. The copy is made transparent with oil and this used as the negative against photographic paper. The oil can be washed out with a suitable solvent. If a large amount of copying is to be done, a camera fitted with a back to receive photographic paper has been described by A. Worischek.[3]

Examples.—Table I, page 1931, illustrates some of the conditions necessary in obtaining enlargements with the Model *B* Balopticon and are given in order that any one wishing to make use of the method can form some idea of the exposures necessary and the range of sizes possible. The results are given for satisfactory enlargements from positives and negatives of very considerable contrast.

Other Types of Enlarging.—The amateur photographer who has access to a lecture lantern can obtain quite satisfactory enlargements by the method described provided his negatives are small enough to go into the projector (with the device suggested under **Positives and Negatives**). Films may be used by binding between two clean glass plates held together with adhesive tape. Of course, the better grades of paper should be used although ordinary papers are better than special enlarging papers as the illumination is much greater than used in ordinary enlarging work. This method of enlargement may also be used to make enlargements of tabulated or graphic data suitable for framing and hanging in the lecture room or laboratory.

The writer wishes to acknowledge with thanks helpful suggestions received from Mr. W. M. Hinman, Secretary of the Chicago Section of the American Chemical Society.

[2] *Science*, **67**, 535 (1928).
[3] *J. I. E. C.*, **12**, 679 (1920).

The American Cyanamid Co. is enlarging its plant, at a cost of 4 million dollars. The annual production of cyanamid at Niagara Falls is to be increased by 100,000 tons to 355,000 tons. The extension of the company's Ammo-Phos works at Warners, New Jersey, will increase production by 48,000 tons per annum.—*Chem. Age*

MORE EFFECTIVE INDIVIDUAL LABORATORY INSTRUCTION IN GENERAL INORGANIC CHEMISTRY*

W. E. BRADT AND E. H. SMOKER, UNIVERSITY OF CINCINNATI, CINCINNATI, OHIO

The student body of the Liberal Arts College of the University of Cincinnati is largely composed of graduates of the excellent high schools of the city and its vicinity. Seventy-seven per cent of the students who take chemistry have had a previous high-school course.

This situation has convinced the authors that the usual type of laboratory manual for freshmen use is inadequate for their purpose. Consequently they have devised a series of experiments, each longer, more elastic, more quantitative in character and probably more interesting than the common type of experiment. The two-fold object has been first to obtain a more individual method of instruction with correspondingly sharper lines of demarcation between the abilities of students, and second, to place more emphasis on the basic principles of the science.

The writers plan a series of papers to explain: first, the general arrangement of the course; second, the general arrangement of the individual experiments; third, to show the instruction system used in their execution; and fourth, to give a detailed discussion of several experiments including data obtained from their quantitative features. This paper will cover the first three items.

General Plan of the Course

The series of experiments is designed to cover those topics usually included in a general chemistry manual in a manner presenting to the student fewer but more difficult tasks.[1] Twelve experiments represent approximately three-fourths of a four semester-hour course. The time remaining after their completion is occupied by work in qualitative analysis. Accordingly, each experiment includes a great deal more than would be covered by any twelve experiments of an ordinary current manual. For example, the oxygen experiment includes as chief topics, history, occurrence, preparation, properties and uses of oxygen, calculations based on equations, catalysis, gas laws, temperature scales, and gram molecular volume and weight. This subject matter is all closely related to the investigation of oxygen, but in the usual laboratory manual would be developed by from three to five experiments.

* Presented before the Division of Chemical Education at the 77th Meeting of the American Chemical Society, Columbus, Ohio, April 29 to May 3, 1929.

[1] The following titles will indicate the general content of the course: Fundamental Concepts, Approximate Determination of Atomic Weights, Accurate Determination of Atomic Weights, Oxygen, Hydrogen, Water, Molecular Weights, Halogen Acids, Halogens, Volumetric Analysis, Periodic Law, and Inorganic Preparations.

Any theoretical significance which may be attached to a particular phase of a general topic is treated as part of the experiment dealing with that topic. For example, the standard for gram-molecular volume, and consequently for gram-molecular weight, of volatile compounds is intimately connected with the general topic, oxygen, and therefore is included in the oxygen experiment. A similar relationship exists between equivalent weight, valence, and the general subject, hydrogen, so all are placed in the hydrogen experiment.

A division of a course into larger tasks has the following effect. The type of student, who always finishes a three-hour experiment in two hours, and who either leaves early or wastes the last hour, finds no excuse for such conduct. Unless a three-hour experiment is very carefully designed, some students will suffer for lack of time, while others cultivate undesirable habits of work because of too much leisure. The writers have found that the use of a larger task cultivates better working habits in good students without injury to the weaker students.

The larger experiment is divided into paragraphs which frequently correspond to the short experiment of the current manuals. A poor or uninterested student will always treat these as separate units, and will fail to see the relationships between the various topics, whether they are in the form of separate experiments or of paragraphs in the same experiment. The writers are more interested in the development of each student to the maximum of his application and ability rather than the placing of emphasis on the teaching of either the weak or the strong student. An interested and conscientious student will more readily see the connection between various topics in an experiment than between the same topics in the form of separate experiments which are performed during different laboratory periods and written up as isolated units. These relationships are emphasized by means of study topics, references, quizzes, and notes.

It is common knowledge that the desirable college student is more easily interested in a course which represents difficult work. Accordingly, these experiments have been designed to accomplish this end. Where possible, quantitative studies are made on substances whose identity is unknown to the students. In the approximate determination of atomic weights, the specific heats of "unknown" metals are estimated, while in the accurate determination of atomic weights, the per cent compositions of the oxides and sulfides of "unknown" metals are found. This feature not only tends to discourage dishonesty, too frequently apparent when quantitative relationships are measured, but also affords a very satisfactory basis for grading the student. It is always preceded by the treatment of a "known" by the same method. In writing up the experiment, emphasis is placed upon a complete and accurate record of quantitative data,

rather than on a flowing account of laboratory manipulation. For example, in specific heat measurements, temperature readings at ten-second intervals, and in the estimation of the water of crystallization, the various weighings necessary to obtain constant weight must be recorded in detail. Notes are graded carefully with this requirement in view. An attempt has been made to make each experiment sufficiently elastic so that there is an indefinitely large task for the student who desires to attempt it, and so that this task will include a minimum requirement which will be within the reach of the conscientious but weak student.

General Plan of Individual Experiments

Outline of Plan.—Each experiment is constructed on the following general plan.

- Title and number of experiment
- Purpose
- Topics covered
- Required references
- Optional references
- Apparatus and materials needed
- Laboratory procedure
  - (*a*) Preparations and properties of substances, where pertinent
  - (*b*) Manipulation designed to demonstrate theoretical phases
  - (*c*) Quantitative procedure where possible, using "knowns" followed by "unknowns"
  - (*d*) Calculations of and conclusions from results obtained in *c*
- Exercises
- Study topics
- Student notes
- Quiz

Required References.—Required references for each experiment total from 100 to 200 pages distributed among ten or more books, which are college textbooks of chemistry and physics describing the subjects of the experiment. Among these are several standard first-year texts, the lecture text, one or two more advanced books, and handbooks of chemistry and physics. The required references are very helpful. They prove very serviceable in cultivating correct habits of study. Students who ask needless questions are refused an answer until they have consulted the required references. This policy gives the assistants more time for giving help to the student who really needs it and prevents the omnipresent laboratory pest from monopolizing the services of the assistants. In order that they may always be available to the student, the required references are kept on a table in the laboratory. Their use is an important factor in the assignment of an elastic task. As the name indicates, all required references are supposed to be studied by each student. However, quiz

questions are taken only from the lecture text, one other specified required reference, and the experiment. This constitutes the minimum task and also usually defines the amount of reading done by the slovenly student. The superior students uniformly read all or a majority of the references. As would be expected, these students show in quizzes and examinations a much more thorough understanding of the topics of the experiments. The time spent in reading the references does not materially delay the progress of these students as compared with the progress of the uninterested students.

Optional References.—The optional references, any two of which must be read, are chapters from chemistry books written in popular style. The assignments are not correlated to touch the subject matter of the experiment. Instead, the student is encouraged to read in the same two books each time. Thus at the end of the year he will have read both of the chosen books in logical order. This feature is designed to interest the student in the science and to encourage the use of the departmental library. Books used are: "Chemistry in Modern Life," by Arrhenius; "Chemistry in the World's Work," by Howe; "Chemistry in Industry," Vol. I and II; "What Price Progress?" by Farrell; "Creative Chemistry," by Slosson; "Discovery," by Gregory. Since many of our students are taking chemistry as a pre-medical requirement, "Chemistry in Medicine" will be included next year. The student is assured that the reading of the optional references is not preparation for an examination. He is urged to try to enjoy rather than to study the optional reading. He is also advised to read those books which interest him and is told that he is expected to give only occasional proof that he has read the optional references. Results have more than fulfilled expectations.

Exercises.—Exercises usually take the form of problems to be done outside of laboratory hours. Occasionally graphs, outlines of references read, review outlines, and material to be memorized are required. Unfortunately, in any assignment of problems, the conscientious student, who does the work thoroughly and honestly, may receive the same mark as the student who obtains his results from some one else. This fact is at least partially nullified, by means of quiz questions based on the problems, by using the principles involved in subsequent experiments, and by giving little weight to the problem grade. Grades on exercises and quizzes are so weighted that the student who gains 100 points, or a perfect mark, by copying problems will lose 200 points on the quiz, because he will not be able to work the two problems placed in the quiz questions.

Study Topics.—The study topics consist of a list of subjects and questions based both on the experiment and required references. After the completion of the experimental work, the student is expected to be able to discuss thoroughly any study topic. By this means the entire subject

matter of the experiment and required references is presented to the student for study and review. Most students make use of the study topics. The authors find the topic a more satisfactory form than the study question because students cannot memorize answers and therefore endeavor to understand a subject when it is presented as a topic.

Quizzes.—Quizzes are written, and consist of from five to ten questions concerning the experimental procedure, results, calculations, references, exercises, and study topics. They include at least two problems similar to those assigned in the exercises. The quiz mark is given greater weight than that for any other part of the experiment. It is supposed to represent what the student knows about all phases of the experiment. This emphasis of the quiz mark is made to accord with the assumption that what the student has learned is more important than any other one phase of the experiment. It also discourages tendencies to slight portions of the assigned work. In this way a value of about thirty-three per cent of the final mark on the experiment is allotted to the student's knowledge of the work done and principles covered.. It also lessens the possibility that a student, who is not familiar with laboratory procedure and apparatus, will suffer too much from laboratory mishaps and errors due to the lack of accurate equipment and poor technic. The written quiz is made practical by the longer experiment and is desirable because the instructor can eliminate the variations in grading standards which occur when the quiz is conducted orally by assistants. Students who receive a mark of less than 60 per cent may take a second quiz and receive the average of the two marks.

System of Instruction

Personnel.—Since one aim of the series of experiments is to give to the student a more personal and individual instructional service, and with this to obtain a more accurate estimate of each student's ability and accomplishments, a special arrangement of the available instructional staff was adopted. At the University of Cincinnati, a laboratory section consisting of about 70 students is in charge of three graduate assistants and one instructor. Two assistants are designated as the "floor assistants" and the third as the "record assistant." The latter, under the supervision of the instructor, makes out all quizzes, keeps all records, assigns experiments, inspects notes, issues "unknowns," and records results as obtained and reported by students. His duties are designed to relieve the instructor of any details which would normally interfere with his personal contact with the students. The instructor in this way is enabled to serve those students who most need his help. The use of a record assistant makes possible a very complete record of each student's work and in this manner furthers individual instruction and individual grading.

Typical Record of a Single Experiment.—In the oxygen experiment, the record assistant kept the following records and grades for each student. These were used in computing semester grades and in checking and correcting student laboratory results and calculations.

1. Weight of $KClO_3$ used in quantitative preparation of oxygen. (Reported by student before oxygen generation).
2. Reported loss in weight of $KClO_3$ during oxygen generation.
3. Date and time of oxygen generation (verified by floor assistants).
4. Reported uncorrected volume of oxygen obtained.
5. Reported barometric pressure.
6. Reported temperature of oxygen.
7. Date and time of No. *3*, No. *4*, No. *5*, and No. *6* are reported. (These data required to be reported immediately after oxygen generation and before calculation of volume at standard conditions.)
8. Grade in per cent on laboratory technic of experiment and condition of desk. (To be obtained from floor assistants.)
9. Grade in per cent on No. *2* based on laboratory results.
10. Reported per cent of oxygen in $KClO_3$.
11. Grade in per cent on the mathematical calculation of the per cent of oxygen in $KClO_3$. (Assume No. *2* correct).
12. Grade in per cent on reported barometric pressure.
13. Reported vapor pressure of water at the reported temperature.
14. Reported corrected pressure of oxygen.
15. Reported volume of oxygen at standard conditions.
16. Grade in per cent on reported volume of oxygen at standard conditions.
17. Reported density of oxygen as calculated from No. *2* and No. *16*.
18. Grade in per cent on reported density of oxygen assuming No. *2* and No. *16* to be correct.
19. Gram-molecular volume of oxygen as calculated from No. *18*.
20. Grade in per cent on reported gram-molecular volume of oxygen.
21. Grade in per cent (times five) on written quiz.
22. Grade in per cent (times three) on student notes.
23. Grade in per cent on exercises.
24. Total points made as per cent.
25. Average grade in per cent on oxygen experiment.
26. Record of penalties in per cent due to failure to report data at specified times before proceeding with the experiment.
27. Corrected final grade in per cent on oxygen experiment.

It will be noted that ten grades are computed and recorded in per cent and that they are so weighted that a student may make a maximum of 1600 points. A grade based on such a detailed record is assumed to be an accurate measure of a student's work. In order that an error made in the first part of the experiment may not lower all subsequent grades and thus penalize the student several times, most grades are based on the assumption that all previously graded data are correct. Accordingly, each grade represents only one step (sometimes chemical and sometimes mathematical) of the student's work. Attempts to calculate results before

reporting bona fide data become obvious and are heavily penalized. This penalty uniformly falls on the dishonest and careless student.

Duty of Floor Assistant.—The primary duty of the floor assistant is individual student instruction. They supervise experimental methods, help the student sense the chemistry involved, and correlate the laboratory work with the references, theoretical phases of the experiment, and the lecture course. The floor assistants are available to the student at all times for help on any part of his work. They also supervise quizzes, report absences, grades on laboratory technic, and other data to the record assistant.

As stated above, this series of experiments covers approximately the same subject matter that is found in current laboratory manuals. However, it is presented in a fashion not previously used, and is so designed that each student may work to the limit of his interest and ability. The authors find that these experiments create in the student a desirable reaction toward laboratory chemistry, and that they enable the instructor to more nearly render individual student instruction in large laboratory sections. In subsequent articles, they will attempt to demonstrate the efficiency of the experiments and recommended methods of instruction.

Summary

Original features of freshmen chemistry laboratory experiments and methods in use at the University of Cincinnati are described. An effort is made to avoid elementary experiments and to present to the student a task challenging his ability. Special features of each experiment are: (1) the required use of several references in the laboratory, (2) systematic reading in popular chemistry, (3) the length, each requiring from twelve to eighteen laboratory hours, (4) an elastic task which will challenge the better student while presenting an acceptable minimum requirement within the reach of the weak but conscientious student, and (5) a written quiz. Although laboratory sections are large, a detailed record of each student's work and individual student instruction is made possible by a special arrangement of assistant's duties.

World Output of Artificial Silk in 1928. The world output of artificial silk in 1928, according to German calculations, was 347,400,000 lb., as compared with 266,868,000 lb. in 1927. Individual productions by the various countries of the world in 1928 and 1927 (the latter, in brackets) were as follows, in pounds weight: United States, 98,650,000 [75,050,000]; Great Britain, 52,000,000 [38,803,000]; Italy, 45,000,000 [36,000,000]; Germany, 41,000,000 [31,000,000]; France, 30,000,000 [21,000,000]; Holland, 16,500,000 [unchanged]; Belgium, 15,000,000 [13,500,000]; Switzerland, 12,000,000 [10,340,000]; Japan, 12,000,000 [8,000,000]; Poland, 7,500,000 [4,000,000]. —*Chem. Age*

OUR CHANGING EDUCATION*

A. L. FERGUSON, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

These meetings, at which chemists discuss educational questions, constitute one of the recent outstanding accomplishments of the American Chemical Society. Chemists have generally contended that about the only requirement to teach chemistry is a knowledge of chemistry. They looked with unconcealed disdain upon suggestions that there is value in studying principles of education. In the face of such a prejudice, it took great courage for the founders of this Division to propose that programs of the American Chemical Society meetings should include papers on chemical education; and much greater courage to propose the publication of a journal devoted to this subject. At first an attitude of disgust was evinced by chemists at the mention of publishing articles in THIS JOURNAL; matters of education were considered beneath the dignity of chemists. Tremendous persistence and untiring effort were required on the part of those supporting the cause to demonstrate the value of their ideas. How well they have succeeded is evidenced by the circulation and national or even international recognition which the JOURNAL has today, and by the attendance and interest shown at meetings like this.

To teach should be the first duty of educational institutions, universities as well as others, and by teaching I mean more than the mere imparting of information. The poorest teaching in our whole educational system is found in our universities, and the chemistry departments are among the greatest offenders. This is due, largely, to the attitude already mentioned—that a thorough knowledge of a subject is the only requirement for a teacher. A teacher, before he can do his job properly, should have settled in his own mind what constitutes the aims and purposes of an education, and how his subject fits into the scheme. There is more to be done than simply to make assignments and hear recitations.

"How is the student to prepare himself to teach?" is a question that I have been asked frequently. So far as subject matter is concerned, that can be obtained in any good college or university, but the student finds very little assistance in these institutions, especially in the chemistry departments, to prepare him in other respects to teach. This condition is due, probably, to the attitude of the heads of departments toward the subject of education. Directors of chemistry departments are authorities on chemistry, but in general have little sympathy with the idea that there is anything to be gained through a study of principles of education or principles of teaching. The situation is being remedied slowly through the influence of the Division of Chemical Education. This attitude by directors

* Paper read before the Division of Chemical Education of the A. C. S. at the 77th Meeting of the Society, April 29–May 3, 1929, at Columbus, Ohio.

may be due in part to the activities and nature of work included in our education departments.

Keen and numerous criticisms have been offered by chemists and other scientists against the work of departments of education. Much of this, I agree, is justified, but that is no excuse for discarding all work which pertains purely to the teaching side of our profession. Every teacher of chemistry should be thoroughly familiar with the broad general aims of education; why children go to school from the time they are five or six until they are 15, 20, or 30 years old; what are the divisions of our educational system and the purposes of each; how are these purposes to be attained; to what extent can character, general abilities, true citizenship, and manly characteristics be developed in school? Facts and information, in my estimation, do not constitute an education. A teacher who knows his subject and is even highly successful in imparting information to his students may fall far short of fulfilling his obligations. As I have stated elsewhere, the obtaining of facts in high-school chemistry is not the main purpose of the course. If properly taught, its disciplinary value is much greater. Chemistry is one of the best subjects in the high school to develop reasoning ability, accurate observation, correlation of facts, self-control, clear statements of observations, etc.; abilities and habits of infinitely greater value in later life than mere information.

I realize that the doctrine of mental discipline implied in these statements is considered old-fashioned and entirely out-of-date by many present-day educators. This principle has been displaced by the one "follow the child," that is, the principle that the child should be asked to do only those things he likes to do, the things that are pleasing to him. The amount of lime that this new plan is placing in their backbones is evidenced by the manner in which they do *not* stand up today under temptation and the stress of hard work and reverse circumstances.

Those who have children in primary and secondary schools today have undoubtedly observed a pronounced change in the attitude taken by many school officials and teachers toward these disciplinary objectives of education. Many so-called educational psychologists and professional educators have long maintained that it is not possible to develop and train such abilities and habits in children. These conclusions have been accepted by school administrators all over the country and as a result profound changes in educational objectives, teaching methods, and subject matter have been made. The conclusions of educators have not been accepted, however, by many outside the education departments and teachers' colleges; yet we have all stood aside and calmly and quietly permitted the most radical changes to be made without offering a protest. This is due largely to the bureaucratic control which the educators have over our educational system. The great masses of people sense the changes and express their

disapproval in private conversations, but are helpless to prevent them. People in a position to do something, such as members of faculties in colleges and universities, are too deeply engrossed in their own special fields. We must realize, however, that these changes will eventually react to a most marked degree upon developments in our field, and they are therefore of deepest interest to all of us.

The ultimate advancement of our own science depends upon those who come to us from the high schools. The type of training given in the primary and secondary schools should, therefore, give us much concern. The influence which the changes in primary and secondary education are producing have been distinctly noticeable for several years. Freshmen, at least at Michigan, are lacking in several fundamental respects. A pronounced deficiency in disciplinary training is clearly evident. This is due to a lack of "honest-to-goodness" work in subjects like algebra, geometry, Latin, physics, and chemistry. Students are unable to apply themselves rigorously to assigned tasks; they are unable and unwilling to dig things out for themselves; they are highly superficial; they do not know what real hard work is like; they are easily discouraged and lack persistent effort. For one who would make a success in chemistry in the future these disciplinary abilities are absolutely essential, more so now than ever before. What can college chemistry teachers do with this raw material coming to them today from our high schools? The result will be that a Ph.D. degree will mean about what a B.S. in chemistry used to. To complete their preparation men will have to remain one or two years after obtaining a Ph.D. degree. A trend in this direction is distinctly evident now.

The success of any process or system is best tested by the quality of the product it turns out. So far as preparation for higher education is concerned the test when applied to our new primary and secondary school systems shows a product that is becoming more inferior each year. To this the educators reply that the present system is not designed to prepare the few for college, but the many for the other activities of life. In order to apply the critical test in these other activities, many people were consulted, including bankers, merchants, department store managers, chain-store managers, and factory superintendents. The men interviewed had been in their positions long enough to permit a comparison between the young men and women coming to them now and those who were trained under the older system. So far the verdict has been unanimous that those of today are not as well prepared for the various positions as they were formerly. This is a pretty severe indictment of the "new education."

Members of the American Chemical Society and similar organizations are the ones best fitted to say what shall be taught in our schools, and the methods to be used, and the general nature of the educational influences under which the boys and girls of this great social organization shall be

brought up. We have been inclined, however, to leave such matters to the educators. It is natural to feel that questions of education could and should be left to educational specialists. On the other hand, our experience indicates that specialists frequently become very narrow in their views and overzealous in promoting what a broader analysis shows to be mere hobbies, fads, and unwarranted luxuries. When we study some of the statements and recommendations which have been made and are now being made by professional educators, and analyze the evidence upon which they are based, and when we compare the graduates of the high schools of today with those of twenty years ago, some of us wonder whether it is not high time to step in and take a hand and hold the educators to account. Furthermore, it is a keenly personal matter for those of us who have children to pass through this educational factory.

The doctrine of mental discipline has received the brunt of attack by the education specialists. According to the new psychology, general mental abilities and powers do not exist, there are no generalized habits, modes of action or faculties. We do not have such things as memory, reasoning ability, imagination, sound judgment, keen observation, will power, concentration, open-mindedness, tolerance, rectitude, and the other attributes which have been grouped together and covered by that broad term "character." Geometry may develop the ability to reason in geometry, but will not assist in reasoning out the problems of chemistry or of daily life. Memorizing Latin vocabularies will help in Latin but will not develop a memorizing ability which will help in chemistry. Chemistry may develop keen observation of chemical phenomena, but will not develop an ability for keen observation in any other field. This new psychology was proposed and has continued to thrive in the leading colleges of education, from which come most of the faculties of other schools of education and school administrators. Under such circumstances there is no wonder that our educational system has undergone changes revolutionary in nature. The old system has been torn out by the roots. The very purposes and objectives of education, and naturally the methods of securing them, have been changed. Subjects like Latin, algebra, and geometry have practically no value according to the new psychology and many are advocating that they be discarded. Physics, chemistry, history, geography, modern languages, etc., have been largely reorganized and are due for even greater changes or elimination.

In this connection permit me to quote from a recent book by Professor W. H. Kilpatrick of Columbia University. The title of the book is "Education for a Changing Civilization."[1] Some statements from this book follow.

> Before asking more closely as to school procedure, it may be well to bring together the outstanding separated elements of our problem thus far differentiated. We face

[1] The Macmillan Co., New York, 1926.

as never before an unknown shifting future. This demands that our children learn to adapt themselves to a situation which we, their teachers, can only partially foresee. This in turn means the stressing of a new and different kind of learning, not as hitherto of fixed answers, but of methods of attacking novel situations. Any effort on our part to tie the pupils to our chosen ways may well be just that much to tie their hands or, worse, bind their minds when they most need to be unshackled.... By a proper study of society, its ways and its resources, we must look as far into the future as we can to catch its problems. This practice must permeate our curriculum. While we cannot be sure of the precise details of future social problems—and for real education it is better so—we can within certain limits foretell that certain unsolved problems will press for solution. These with proper care for age and interest will furnish excellent subject-matter for the kind of study demanded above for the unknown future. Here methods of attack upon that shifting future can be worked out and learned.... As we plan for a better world, to deal with the old is difficult, but for the young, prospective social problems furnish us the best intellectual subject-matter they can have.

If some wonder how, in an already crowded curriculum, we can find time for the extended study of social problems here demanded, one answer is clear. Rid the schools of dead stuff. With those who are in fair touch with educational thought, the opinion grows that the present secondary curriculum remains not so much because it is defensible as because we do not have assured material in workable form to put in its place. For most pupils Latin can and should follow Greek into the discard. Likewise, with most of the mathematics for most pupils. Much of present history study should give way to studying of social problems. Modern foreign languages can hardly be defended for most who now study them. With reference to English and the sciences, they need remaking from within rather than rejection. To speak thus in terms of subjects must not be taken to imply that separate subjects is the best teaching unit. The question is moot and must be considered later.

The old notion contemplated a static civilization with problems already solved. Education was to hand these down to the young. That curriculum was, at its best, the ordered arrangement of past achieved solutions. Learning was acquiring these age-old solutions. A passive acceptance constituted "docility," the highest of useful virtues. But we now face an unknown future. We must prepare in a different fashion.

The old curriculum consisted of subject-matter set out to be learned for giving back on demand. The essence of the new curriculum is the child actively at work needing for his present experiences better ways of behaving. The new curriculum consists of experiences.

It seems but true, unfortunate as it is, that most of our traditional school thought and procedure is based upon the older static outlook on life. Such words as learn, teach, study, subject-matter, curriculum, promotion, textbook, objectives, generally imply the static outlook and so prejudice in advance any discussion in which they occur. If this discussion will help to break this strangle hold of tradition, a further end will have been accomplished.

For those who are interested in obtaining a brief treatment of the ideas involved in this new education, I heartily recommend this little book by Kilpatrick.

The direct influence of this new school of psychology is not limited to the primary and secondary schools alone. Pronounced revisions in the curricula of colleges and universities are being made. The movement is being encouraged by some administrators and discouraged by others. The

attitude typical of the opposition is well expressed in the remarks of M. C. Thomas, late president of Bryn Mawr College. Permit me to quote some of her statements.

> Our present so-called old-fashioned college curriculum is based on a judgment of the relative educational value of subjects of study formed by the experience of countless generations of teachers and students and confirmed by our own experiences. Without such judgment we should have no college curriculum.
>
> Latin was the only study that required genuine intellectual effort on my part and gave me joy of mastering difficulties and rewarded me with keen pleasure in splendid content.
>
> As a result of my long experience in watching their effect on our students, I am absolutely and irrevocably sure that certain subjects give, in a much higher degree than others, training in straight thinking and reasoning clearly. It is such thinking subjects that must in my opinion forever be included and emphasized in our curriculum.
>
> A trained intelligence can easily get technical and professional training and at thirty or thirty-five be far ahead, both financially and professionally, of the man or woman who has wasted the previous time of college in vocational work.
>
> But the curriculum of our college is threatened by a terrible foe at the gates—a wolf in sheep's clothing—that can only be kept at bay by the most gallant kind of warfare. For many years we have fought the slogan that any high-school work well done is sufficient for college, but, after all, the high school gave mental work of a well-known and approved kind. Now we are about to see the high-school work itself changed. So-called new-fashioned or modern subjects are to be substituted for the old, tried disciplines. Practical vocational courses are to be given. Latin and Greek are to go. French and German are to be taught by conversational methods. Algebra and geometry are to be dropped also—only so much commercial arithmetic as we use in daily life (which is practically none) is to be taught. History (except the very most modern kind) and all literature (except twentieth century literature) is to be scrapped. Now is the time for us to fight for our educational convictions and save, if we can, our present college curriculum.

I have read dozens and listened to yet more testimonials of this nature. Men and women from practically all walks of life who have made successes of their lives attribute their successes largely to the rigid disciplinary training through which they passed in their early life. Against such testimonials, based upon life's experiences, we have the preconceived notions, opinions, guesses, very superficially confirmed theories, and conclusions of a comparatively small group of educational psychologists who pronounce the whole idea of disciplinary training to be unreal, imaginary, and fictitious. They say there is no such thing as mental discipline as we have generally thought of it, that people for countless generations have just been fooling themselves.

The tragedy of the situation is that this small group is so stragetically located that they have been and are now putting their revolutionary ideas into effect and completely reorganizing our whole educational system. They have control of the large schools of education and teachers' colleges, from which come our school administrators and teachers.

Superintendents and principals feel they must keep their schools up-to-

date. Not long ago I inspected a large city school where the work had been extensively changed to conform to the new ideas. Following the inspection I talked with the principal. He was a Columbia man and had taken practically every course offered at Columbia Teachers' College and was thoroughly familiar with its theories and ideas and the experiments upon which they were based. He surprised me greatly by stating that he was unable willingly to support the things advocated in this new education. Knowing, however, that I had observed many changes in his school to conform to the new ideas, he made this statement by way of explanation: "I must keep my school up-to-date." That, I believe, represents the situation in many cases.

We are aware that most of the would-be educational reformers in our smaller institutions have sat at the feet of educational psychologists in some teachers' college or education department of some university. In many instances a few questions revealed that they were not serious students of the situation, but had simply accepted without question the information handed to them by the "experts," who were looked upon as beings possessed with superpower and whose utterances were not to be questioned. Many teachers have told me they are simply following directions; they do not understand what it is all about, but they must go ahead doing as they are or lose their jobs. Even university and normal school graduates, who were strongly opposed to the new systems, stated they had to continue practicing things in which they did not believe or look elsewhere for positions. Not only this, but they were required to act and talk in public as though the systems were a great success, while in their own hearts they knew otherwise. The claim is made by the reformers that their conclusions are based upon research and the applications of science, and herein lies one of the greatest sources of evil. Practically everybody holds in high esteem the results of research and the works of science. People listen with great respect when a speaker remarks that he is presenting the conclusions of research; there is now a sort of reverence for that term. I believe there is justification for this attitude, and it would be most unfortunate if the general public should lose its present faith in scientific research. But the way some of the educationalists are dragging the terms "research" and "science" through the mud is close to sacrilegious. It hurts to hear the terms applied to some of the stuff printed in educational journals and reference books. The men developing this new field are undoubtedly thoroughly earnest, competent, and sincere in their convictions, but they are with few exceptions educators and not scientists. They have never had a rigid training in scientific principles and practices. They are like a blacksmith working in a watch factory. They have no appreciation of scientific methods. Their publications and conclusions are just what one would expect under such circumstances.

Not long ago I spoke before a small group of parents concerning the changes which have recently been taking place in our educational systems. There was present an educational theorist, nationally known, and one for whom I have much respect. In reply to my statements he remarked, among other things, that he was surprised that a scientist, as I professed to be, should not be willing to accept the conclusions of other scientists, as he called his colleagues. He and his colleagues do not appreciate the meaning of the expression "scientific research." To argue with them is like the attempt of an instrument maker to argue with a blacksmith about making a watch. The refinement and delicacy of the working tools of the scientist are unknown to them, and when they attempt to use these tools it is like an 8th-grade boy attempting to work with vernier calipers or balances accurate to the 4th decimal place.

These statements are based upon a rather extensive analysis of many publications in the educational journals and reference books. From these surveys I am ready to state that no true research man would even consider publishing data of the type and obtained under the conditions such as much that I found. Yet these men not only published their results, but drew the most fundamental conclusions from them and on the basis of these conclusions advised that our whole system of primary and secondary education be reorganized. Upon this advice, coming as it did from assumed authorities, the superintendents and principals all over this country have proceeded to bring about this reorganization as rapidly as possible. In our larger cities the reorganization has progressed a long way. The slogan now appears to be that the greatest unsolved problem in education in this country today is the rural schools. May I state there is at least one problem in education which is greater, and that is, how to undo the damage which has already been wrought in our city schools, due to the reorganization which has recently taken place?

Please do not understand from these remarks that I am opposed to everything which is of the nature of a change in education. I believe thoroughly in progress. The very activities of every scientist engaged in research demonstrate his belief in progress. New facts and evidence are continually being submitted and decisions frequently should and must be altered in the light of the new data. But I believe the experiences of every scientist who follows the results of research in any field cause him to be extremely cautious and slow to recommend radical changes in old, established methods and policies. He has too often seen conclusions based upon the results of rigorously controlled and carefully performed researches discarded within a few years. Later work showed that some unknown and unsuspected condition or source of error had been present in the work which completely changed the nature of the results. Also, only too frequently, even among thoroughly seasoned research workers, there is a tendency to interpret

results in the light of preconceived ideas. Many are the instances where an unbiased reader places a decidedly different interpretation upon the same data. When such things happen, and not only happen but are frequent, in the most carefully performed experiments, where the experimental material and conditions are largely within the control of a trained investigator, how enormously greater this uncertainty becomes when the materials experimented upon are human beings, children in our schools, and the conditions are so outside of accurate control as they are in the school room, and the experimenter is some teacher who does not even know the meaning of or the first principles of scientific research. Yet, as I have stated before, some of the educational reformers have taken data obtained under such circumstances and upon it have based most fundamental and far-reaching conclusions. Not stopping with that, they have advised the most radical changes in our educational systems and have taken every means available to see that the changes are made.

I believe that radical changes in such fundamental institutions as our educational systems should be recommended and carried out only after the most rigorous and conclusive tests have demonstrated the success of the new policy. What are the training schools in connection with our univerisities and normal schools for if it is not to do this very thing? These training schools are the great semi-commercial laboratories where the new theories and methods should be tried out and they should be tried for a sufficiently long time to prove that they are enough of an improvement over the old to warrant their being introduced wholesale throughout the country. Our great industrial concerns all maintain research laboratories where new processes are being discovered. Are these new discoveries immediately rushed into the factory and the whole institution changed in order to put them into effect? Any one familiar with successful industrial organizations knows it is not done that way, no matter how insistent or enthusiastic the proponents of the new discoveries may be. They are first tried out in a laboratory on a semi-production basis, in a manner correspondent to the training systems in the field of education. If it is demonstrated there beyond any doubt that the new methods and processes are an improvement over the old and that they are a sufficient improvement to warrant the confusion and additional expense of making the change, then it is made. More proposed changes are discarded by this method of testing than are accepted. I am convinced that had this method been followed in the reorganization of our educational systems, a large number of the changes which have already been made would have fallen by the wayside. In conclusion may I quote from W. G. S. Jones: " 'Keep to the safe path' is a safe rule to follow in all educational matters, partly and perhaps chiefly because the material with which the teacher works is too precious to endanger it needlessly."

THE TEACHING OF QUALITATIVE ANALYSIS IN THE GENERAL CHEMISTRY COURSE*

PAUL H. FALL, HIRAM COLLEGE, HIRAM, OHIO

The inclusion of elementary qualitative analysis in the latter half of a course in general chemistry is apparently beyond the "swaddling clothes" stage. However, the motives for such a course and the methods of presentation may vary widely. Certainly the main motive is *not* to make expert or even semi-expert analysts of the students, but it should be to train them in the scientific method and to aid them in a very effective way in learning chemistry. For example, there is no easier way to learn about the solubilities of the chlorides of the two dozen common metals than to observe a row of twenty-four test tubes, each containing a solution of a nitrate of a metal, to which some hydrochloric acid has been added. By this method the student can easily pick out the metals (silver, lead, and mercury) whose chlorides are insoluble in water or dilute acids. It is no great tax on the brain cells to remember these three, and, by process of elimination, it is a very simple matter to learn and remember that the other twenty-one metallic chlorides must be soluble.

In addition to simplification of the learning of some chemical and physical properties of a fairly large number of compounds, a course in qualitative analysis constantly forces upon the attention of the student practical applications of the principles of (1) equilibrium, (2) solubility product, (3) repression of ionization, (4) law of molecular concentration, etc.

But how shall the course be presented? Shall we use the orthodox method that begins with some preliminary discussion of the principles just mentioned, proceeds to give a table depicting the "scheme" of qualitative analysis—with the metals listed in their respective groups—and then follows with very specific, detailed, matter-of-fact directions for analyzing a "known" or "unknown?"

Or shall we eliminate such slavish "cook-book" work (which such a method inevitably develops and encourages) by choosing a method of approach that leads the student to develop and to work out a general "scheme" of analysis for himself; a method which helps him to work out for himself the details involved in the separation and identification of the different metals in any of the groups?

The orthodox method most assuredly enables the student to analyze a larger number of "unknowns" in the time allotted to the work. But of what real value is this accomplishment if the result has been reached by the "cook-book" route? The quality of qualitative work ought to be of more importance than the quantity.

* Paper read before the Division of Chemical Education at the 77th Meeting of the A. C. S., April 29–May 3, 1929, at Columbus, Ohio.

The writer has used the orthodox method five years and, for the last four years, the method to be described. As a result of critical observation and comparison of the two methods, enthusiasm for the following method is increasing.

By oral instruction and mimeograph sheets, a review is given of *equilibrium* and the *law of molecular concentration*. Experiments that help to make these principles real and comprehensible are given, but *not* in a form such as this: "Add A to B and explain the result." Instead, some simple directions are given and then questions are asked that lead the student to discover for himself certain facts and principles. With this knowledge as a background he is asked questions that involve prophesying or determining what will happen if he does so and so.

Then the *solubility product* principle is plainly and simply discussed, its universal application in all precipitations is emphasized (as well as the solubility of precipitates), the simple mathematics involved is explained and illustrated and some experiments involving the applications of the principles are given. Here again, after requiring the student to make some simple mathematical calculations, in which he determines the numerical value of the solubility product of a certain salt and the ion product obtained by mixing certain volumes of solutions of known concentration, he is asked to predict whether or not he should obtain a precipitate by making such a mixture. This adds zest and enthusiasm to the work, and does eliminate "cook-book" work. Later he is directed to try the experiment and to state whether or not his prediction has been fulfilled and to give the evidence.

For the beginning of strictly qualitative analysis, suitable racks, containing test tubes of various solutions, are placed in convenient locations for the students' inspection. The first rack contains twenty-five test tubes of solutions, each containing a metal nitrate and each labeled according to the cation present. A placard is placed on the rack labeled "Metal ions treated with HCl." The students are directed to examine, to observe which metals yield precipitates (chlorides), and to list these metals as Group I, calling them the "Hydrochloric Acid Group." They are also asked to list the color and the formula of each precipitate.

A second rack labeled, "Solutions of the metals, except those found in Group I, to which H_2S has been added," contains twenty-one labeled test tubes. The student is directed to observe as in the first case and to list as Group II, "The Hydrogen Sulfide Group," the metals whose chlorides are soluble in water or dilute acids but whose sulfides are insoluble.

In a similar manner the rest of the metals are classified into their respective groups, *but*—and this is the important thing—the student classifies the metals himself. Then he is asked to outline a general "scheme" of analysis. To guide him a skeleton table is given him in which question marks are used instead of metal ions or compounds. From the group division he has just

made for himself he can fill in the proper metals or precipitating agents in place of the question marks.

This method consumes considerably more time than would be required to have him gaze upon a properly prepared printed chart or "scheme" of analysis but the value of such a method and the benefits derived therefrom seem to the writer to outweigh by far the extra time consumed. Furthermore, the student realizes that certain metals fall into certain groups because of the insolubility of their chlorides or sulfides, etc., and *not* because some author or committee thought such a division would be a nice scheme. An instructor inspects the tables thus prepared by the student before he is permitted to proceed with a subsequent experiment.

In our course in general chemistry a study of the metals does not precede our laboratory course in qualitative analysis but it constitutes an integral part of the qualitative work, since one purpose of the course is to aid the student in learning chemistry and also to aid him in applying what he is learning.

After the metals have been classified and a general "scheme" of analysis has been worked out by the student himself, we take up individual experiments on the properties of silver and its salts, getting the metal into solution and also finding solvents for some of the salts of silver. In a similar manner mercury and lead and their salts are studied. All the while the method of giving directions for experiments to be performed and asking questions on the results obtained is such that will lead the student to see how he can make use of certain properties of a substance, or certain reagents, so that he can separate a particular metal from others and obtain a confirmatory test for it. Then follows an experiment such as this: "From what you have learned about the properties of certain salts of mercury and silver in Exps. 14 and 15, explain how you would proceed to separate a mixture of the metal ions and obtain confirmatory tests for each. Try the separation and tests by taking a mixture containing about 4 cc. of a solution of each salt ($AgNO_3$ and $HgNO_3$)."

After lead is studied, the student is directed to outline a method for the separation and identification of lead, silver, and mercury in a mixture of the three. He is then required to analyze "Known No. 1" according to the method which he himself has just outlined. A special form of "known analysis" sheet is furnished him, having five vertical columns labeled, respectively, Procedure Number; Substance; Treatment; Result; Equation Expressing the Reaction.

This sheet is inspected by the instructor and the student is questioned concerning the procedure and the method he would use in analyzing an "unknown" that might contain only the metals of Group I. When the instructor is satisfied that the student knows "how," "what," and "why," an "unknown" is issued him with a special form sheet for recording his operations and conclusions.

By the method of filling in the above "known analysis" sheet the student demonstrates whether or not he really understands what it is all about. Our experience of the last four years has been that a very high percentage of the students really do gain a comprehensive knowledge of "how," "what," and "why." Furthermore, the students relish the work because they realize that the methods of analyses that they outline are the result of their own labors and their own thinking and logical conclusions. They feel that it is of far more value than a "cook-book" procedure.

After the "knowns" and "unknowns" for Group I have been analyzed, there follow experiments and questions on metals in subsequent groups, and in each case the student works out his own method of analysis, guided aright, of course, by reactions that will lead to the desired end and by questions that involve applications of the information thus obtained. Thus in each case the student develops his own methods for the separation and identification of the metals within each group.

Naturally this method consumes much more time (hence fewer "unknowns" can be analyzed) than if the student is required to follow printed specific details of procedure for separation and identification of the metals. What evidence is there that such a method as here described is of sufficient value to warrant the time consumed? In the first place, there is no question but that the student gains a better understanding of what it is all about. And if this were all that were to be gained, the results would justify the slower method. But perhaps the best criterion is the judgment and enthusiasm of the students themselves. With only a very few exceptions the students have been very enthusiastic about the course and since it comes in the second semester it acts as a good spring tonic. More than once good students who had planned to major in some other department have decided to major in chemistry—a decision reached very largely as a result of interest and enthusiasm that was aroused in the course of qualitative analysis as now conducted. But most important of all, this method gives the student the research spirit and makes him feel that he too can apply the scientific method.

China Steel. Various types of substitute materials have appeared from time to time that gave the general surface appearance of clay wall tiling. They have included enameled paper, wall board, and composition tile. Those that have survived have found a substantial market resulting from the present demand for attractive, elaborately fitted lavatories and bathrooms.

Now comes a new material, "China Steel," with a porcelain enamel coating on die-formed metal tiles, specially designed for nailing into place. The surface coat of the new tile is very similar to that of the more expensive clay, and the joints may be pointed up in much the same way. It is lighter, thinner, and is warranted not to crack. Perhaps the greatest potential advantage is the freedom from dependence on skilled tile setters.—*Ind. Bull.*, Arthur D. Little, Inc., **No. 32** (Aug., 1929).

THE TEACHING OF QUANTITATIVE ANALYSIS IN SECONDARY SCHOOLS*

HERBERT R. SMITH, LAKE VIEW HIGH SCHOOL, CHICAGO, ILLINOIS

If by the term, quantitative analysis, we mean only that type of analysis which we studied at college or university (and most of us do) we will find no time or place for it in the beginning year of the study of chemistry. But there is a type of quantitative analysis having values which are superior to the average laboratory experiment in first-year chemistry. It does not seek an entrance in the course as a sample of what is to follow in college, although there is no objection if it does. It has immediate and purposeful values of its own for the pupil even if he does not attend college later.

There is too much emphasis on elementary and secondary schooling as a preparation for college work. We speak of secondary schools as "college preparatory," as if they merely filled in the time until the candidate arrived at the real fount of wisdom. A vicious circle is completed when the college graduate begins as a teacher in the high school and repeats to his pupils the information in much the same form as it was received from the various professors in college and accompanied by their personal mannerisms. We are trying to make the secondary-school education worthwhile for itself, knowing that 90% of the secondary school students do not attend college, and that this foundation is quite as suitable for further training in college as for life work.

If we are to appreciate fully the purpose of quantitative analysis in the first year of chemistry it is necessary to know the present conditions under which we operate. Four characteristic influences of the age make a background for the consciousness of our youth in school.

First: A restless age in the desire to enjoy the fruits of science but a very *restful* attitude on the part of many in constructive thinking and acting.

Second: An increasing tendency of pupils to depend on the spoken word of fellows and teachers and on what some one says in the textbook, rather than the forming of an independent opinion from the facts.

Third: A commercial world offering immediate thrills and fun, but demanding a price and getting it, for the parents furnish the coin of the realm.

Fourth: An educational world offering mental drudgery for nothing with no takers. The parents are not so willing to furnish the coin of the *mental* realm.

* Contribution to the Symposium on "The Teaching of Analytical Chemistry" held by the Division of Chemical Education at the 75th Meeting of the American Chemical Society, April 17–18, 1928, at St. Louis, Mo.

For other Symposium papers see THIS JOURNAL, **5**, 937–89 (Aug., 1928) and **6**, 486–95 (Mar., 1929).

The problem, tersely stated, is to cause achievement to grow in this unpromising soil. The solution is not new for we began on it years ago and by constant trial and test have presented the study of chemistry in the manner that serves human needs. The problems are presented experimentally in project form and those involving the quantitative factor have been the most effective.

The quantitative experiments which determine equivalent, atomic, and molecular weight are dismal failures when the pupils attempt their performance except for about six per cent of the average class. Very satisfactory results are obtained by demonstrating these experiments so that the pupils will have sufficient time to sort out the essential facts of the experiment and know their significance. The outstanding discovery in our research in method this year shows the reason for the failures in the above stated experiments and also the chief cause of failures in any pupil's laboratory work. The details of the experiment so occupy the immediate consciousness of the experimenter that he has no power to select essential data and organize it into a larger concept. If lessons from a textbook precede the experimental work the pupil merely repeats what has been read and acquires no scientific skill. If the experiment is a real inquiry by the pupil according to scientific method, most of the class know only the mechanical details which they have performed. They have not reached the interpretation stage of the study. At the start of the year only 83 per cent of 130 pupils could retain a large enough margin of consciousness beyond the consideration of details to interpret the data. The tests of last month showed about 70 per cent were able to interpret the experimental data.

This improvement has been accomplished by insistence on a consideration of the data by questions constantly applied to this end. By a decided removal of emphasis from textbook to the interpretation of laboratory data we have become thoroughly convinced that descriptive chemistry may inform but it does not educate as we expect it to do. The real purpose in teaching chemistry is training, not mechanical filling; it is thinking, and not repeating; its end is knowledge and not information.

The peculiar value of a quantitative experiment is entirely determined by its method and setting. In determining the concentration of an unknown solution by titration we have destroyed all the enthusiasm of a class for the subject by making it purely a mechanical problem. Then we have undertaken to determine the percentage of ammonia in the various samples obtained from the grocers of the neighborhood and have reëstablished chemistry in the good favor of the class by a project containing a life situation. Others that we have included in our first-year course are analysis of textiles, coal, baking powders, milk, soils, and the effectiveness of oxidizing agents in the production of chlorine. Whenever the interest of a class begins to

fail, a quantitative problem in chemistry involving a life situation never fails to restore it.

It should be understood that such analyses must not be too rigorous and must be understandable by the lower half of the class. This mistake is frequently made. The ammonia analysis experiment originated at Lake View and has been very generally adopted. But as some teachers have reconstructed it, it is a thing of terror because of the unnecessary abstruse calculations introduced. We generally offer a second year of chemistry at Lake View and, in one semester of it, quantitative analysis of the usual college grade if the abilities of the students electing it give the necessary warrant of success.

DISCUSSION

FRANK B. WADE, SHORTRIDGE HIGH SCHOOL, INDIANAPOLIS, INDIANA

Recognizing that second-year high-school courses in chemistry must and should be given in very few schools, we advocate very elementary quantitative analysis as an excellent type of material for use in the third semester of chemistry. The chief use of it lies in the opportunity that it affords for application and review of some of the fundamentals of general chemistry. At Shortridge High School it has also given a moderate number of pupils a chance to prepare for actual work in industrial laboratories as assistants. A canvass of the chemists who employ these pupils resulted in the quite uniform suggestion that the pupils be taught the following general things rather than be prepared for particular positions:

1—Honesty in regard to figures and values obtained in their laboratory work.

2—Facility in the use of the analytical balance, graduated glassware, etc.

3—How to wash bottles, apparatus, etc.

4—The nature of *standard* and *normal* solutions.

5—How to conduct a titration, the use of indicators, end-point, etc.

6—How to carry on a chemical calculation from the data of a titration, etc.

At Shortridge the Course 3, as it is called, is offered only every other semester, and to a selected group of some 10 or 12 chosen from the nearly four hundred pupils of the department. The outline of this course follows:

CHEMISTRY III

This course organized to develop

1. Familiarity with
   - (*a*) Quantitative apparatus
   - (*b*) Use and care of chemical balance and calibrated glassware
   - (*c*) Laboratory cleanliness
   - (*d*) Neatness
   - (*e*) Honesty toward results

The supposition is that students of more than average ability, acquiring the above ideas while working quantitative experiments, will be well equipped for usefulness in any technical laboratory.

I

Review—

1. Atoms, molecules, reactions
2. Symbols, formulas, equations
3. Gram-atomic weights, moles and solution of problems—molal volume
4. Ionization—reactions in solutions—electrons

II

Apparatus involved—

1. Accurate chemical balances
2. Specific gravity bottles
3. Crucibles
4. Desiccators
5. Burets
6. Pipets
7. Graduated flasks

III

Method—

1. Intensive review of Chemistry I and II (see I) covering about three weeks
2. Acquaintance with and use of apparatus developed as met in the sequence of the work. Theory involved accompanies.

IV

Sequence—(a) Gravimetric—

1. Practice weighing of objects—to 4th place
2. Specific gravity determinations
3. Oxidation of magnesium and determination of gain in weight.

V

Sequence—(b) Volumetric—

4. Saturation methods—acidimetry and alkalimetry
   - (*a*) Exemplification—preparation of *N* HCl—C.P. Na_2CO_3 as basis. Introduces standard solutions, normal solutions, indicators, end-point and titration
   - (*b*) Practical analyses of basic substances—examples—lye—washing soda
   - (*c*) Preparation of standard solution of NaOH against *N* HCl
   - (*d*) Practical analyses of acid substances—examples—dilute shelf acids, vinegar, fruit juices, etc.
5. Oxidation processes
   - (*a*) Exemplification—
     - (I) Bichromate process for the determination of iron
     - (II) Permanganate process for the determination of iron
     - (III) Iodimetry—titration of iodine against sodium thiosulfate
     - (IV) Chlorimetry—determination of available chlorine in bleaching powder
6. Precipitation methods
   - (*a*) Exemplification—determination of silver in coin.

VI

Stoichiometry—

Interspersed throughout the course.

DISCUSSION

H. A. Mangan, High School, Vandalia, Missouri

Mr. Chairman: My chief interest in a meeting like this is philosophical. It is a part of a study in the grosser aspects of behavioristic psychology. There is the frequently occurring condition of the gravitation into two camps. That of the representatives of the rigor of research methods and that of those who would seem inclined, by their own emphasis, to denature subject matter. There is no real difference. The grinding in of fundamentals may be done in at least two ways: by segregated drill which has a deadening effect; or by demonstrating that the course in chemistry or any other subject has continuity. This latter may be done by bringing out, and not failing to call attention to, the fundamentals underlying each case. The greatest good that could come out of such meetings as this is a frank realization that our point of contention, in this particular, constitutes a distinction without a difference. It is simply a result of a shift of the point of emphasis on the same condition.

The Sources of Tantalum. In a recent report on tantalum, the United States Bureau of Mines, Department of Commerce, says that its sources, uses, and markets are very limited. Should an unforeseen and unexpectedly large supply of ore become available, it is not likely that the demand would increase in proportion; in fact, the price would probably fall unless the supply were closely controlled.

Tantalum is found in comparatively few minerals and under narrow geologic conditions. It is one of a pair of metals that are almost unknown separately, although columbium, the other member of the pair, is sometimes reported alone in minerals. The metals are very difficult to separate, possibly more so, excepting zirconium and hafnium, than any other pair of closely associated metals, such as gold and silver, rubidium and cesium, uranium and thorium, and the rare earth metals. The tantalum minerals have been found exclusively in pegmatites or in deposits closely related to the pegmatites, and outside the real pegmatites the deposits amount to little.

Although there is a fairly long list of tantalum minerals, few are of importance. Columbite is by far the most common and the most important; it is a very variable tantalate and columbate of iron and manganese, which may contain almost no tantalum or almost no columbium. If the quantity of columbium is very small, the mineral is known as tantalite. The content of iron and manganese may also vary. If a tantalite contains almost no manganese, it is dense black and is called tapiolite (also known as skogbolite); if manganese is present to the almost total exclusion of iron, the mineral is a beautiful translucent red and is called manganotantalite. Antimony or calcium (lime) may be present almost to the exclusion of manganese and iron, and the minerals are then known as stibiotantalite and calciotantalite, respectively. The elements listed above are only the principal elements occurring in these minerals. All the tantalum-columbium minerals contain small quantities of other elements.—*Mo. Met. Sec., Chem. Age*, **21**, 13 (Aug. 3, 1929).

PRESENT SPECIFIC OBJECTIVES IN HIGH-SCHOOL CHEMISTRY*

KIMBER M. PERSING, GLENVILLE HIGH SCHOOL, CLEVELAND, OHIO

A review of the field of high-school chemistry shows a lack of a complete detailed summary or list of the specific objectives in this subject. The purpose of this study is, first, to investigate the field of high-school chemistry and find all the specific objectives in approved courses of study, in textbooks and in carefully conducted curriculum investigations; and second, to give to each objective a measure of its frequency of occurrence in each of the various sources investigated. An evaluation of the objectives beyond the measure of its frequency of occurrence presents a new problem which would require additional research from a different approach and which is not essentially within the scope of the present study.

A Tentative List of Sources

The selection[1] of a tentative list of sources of objectives was the first problem to be considered. It was decided that this tentative list of sources of objectives should consist of curriculum investigations, courses of study, and textbooks. The curriculum investigations selected for the tentative list were limited to those which dealt with the subject matter or its aims in a quantitative manner. The courses of study, included in this list, were those recommended by the Teachers' College Bureau of Curriculum Research and several others which seemed worthwhile. The matter of textbook selection for this list was somewhat more difficult because of the long list of available texts. Nine were finally selected as being representative of the more widely used and popular texts.

Tentative List as a Questionnaire

The tentative list of sources was submitted to twenty-four judges, chiefly chemistry teachers, as follows:

Harold Baker, West High, Cleveland, Ohio
H. E. Brown, Lincoln School, Teachers' College
Gerald S. Craig, Horace Mann School
J. O. Frank, Wisconsin State Teachers' College
Neil Gordon, Johns Hopkins University
C. W. Harp, High School, Hagerstown, Md.
Henrietta Hayden, High School, Syracuse, N. Y.
Harry N. Holmes, Oberlin College
Ruth Johnson, High School, New York

* Read before The Northeastern Ohio Chemistry Teachers Association at Hiram College, Hiram, Ohio, April 20, 1929.

[1] The procedure adopted for use in making this study is essentially the same as that used by Harap and Persing in their investigation of the specific objectives in general science: Harap, H., and Persing, E. C., "Present Objectives in General Science." Unpublished research.

Theodore D. Kelsey, Grover Cleveland High, St. Louis, Mo.
J. J. Guenther, High School, Omaha, Neb.
Lewis L. Hall, Morgan Park High, Chicago, Ill.
A. I. Lockhart, Horace Mann School
Susan Lovald, Central High, Duluth, Minn.
P. A. Manwell, High School, Williamsburg, Mass.
Ida M. Nicely, High School, Chicago, Ill.
J. H. Norton, Sacramento Junior College, Sacramento, Cal.
S. R. Powers, Teachers' College, Columbia University
R. D. Reed, High School, Lakewood, Ohio
Wilhelm Segerblom, Phillips Exeter Academy, Exeter, N. H.
S. L. Stoner, High School, Sacramento, Cal.
A. C. Stitt, High School, Ann Arbor, Mich.
H. A. Webb, George Peabody College
R. B. Whitmoyer, High School, Atlantic City, N. J.

These educators were asked: (1) to indicate which of the suggested source materials should be included; (2) which should be rejected; and (3) what additional sources should be added to the list. The results of these opinions made possible a final selection of sources to be investigated. The final list consisted of the following:

1. Three curriculum investigations
2. Six courses of study
3. Six textbooks

A list of the sources selected for the study appears in a table preceding the table of objectives, at the end of this report.

Assembling the Objectives

Assembling the objectives from the source material presented certain difficulties. The sources generally did not state specific objectives, and the objectives, when stated, seemed to vary considerably in quantitative value. In investigating sources which did not express specific objectives or aims it was necessary to write the probable implied goal from the content of the source material. And in order that these implied objectives might be of nearly uniform value it was thought advisable to define the measure of the objective to be used in making this study. For the purposes of this study, it was decided to adopt the same measure of an objective, as that adopted and used by Harap and Persing in their investigation referred to earlier in this report. The specific objective as used throughout this study will imply that:

1. It should be concerned with a fairly small unit of life activity
2. It should suggest a rather definite classroom activity
3. It may be accomplished in a fairly short period of time
4. Its achievement may be readily observed or measured

Each objective was written on small individual cards, for convenience later in sorting and distributing under various headings. These cards

carried the key numbers of the source from which obtained. This yielded 1819 cards.

Sorting and Distributing Objectives under Main Headings

The 1819 cards containing the objectives were now sorted into groups under main headings. At this point it was possible to reduce the number of cards by writing the code numbers of an objective on a single card and removing all duplicate cards.

The work of sorting the cards into groups was minimized by using the conventional chapter headings of the textbooks as main headings. The apparent standardization of the subject matter seemed to warrant this procedure rather than adopt another plan of grouping. The few exceptions to this distribution existed with those written from some of the curriculum investigations. These were distributed under appropriate headings in so far as possible, and the remainder placed under a supplementary or miscellaneous heading.

There are several instances in which duplication seems to appear. This could not be avoided without an apparent modification of the meaning as stated or implied.

The grouping of the objectives under main headings yielded 235 objectives which are listed in the table of objectives at the end of this report.

Table of Source Material

The source material investigated in making this study is listed in a table immediately preceding the table of objectives at the end of this report. To each source has been assigned a key or code number which is written in a column to the left of the titles. These key numbers have been used in the table of objectives to indicate the origin or occurrence of each objective in the sources.

Table of Present Objectives

A table of specific objectives is given at the end of the report. This table consists of 235 items resulting from the assembly of the individual items written from the various sources. These objectives will be referred to and discussed later under the several headings of the report.

Some Uses of Table of Present Objectives

The extent to which the table of objectives may serve depends largely upon the worker using it. These objectives may serve the curriculum maker and other educational research workers, in various ways. It may be used as a means of comparison either in writing a new course of study or in checking the course of study now in use.

One of the most interesting features of this study is the bird's-eye view of the high-school chemistry course which it provides. The objectives represent a summary of the present high-school course in chemistry, to the extent that the sources used are a representative sampling of source material, and are not to be interpreted as a list of objectives presented for a new course of study, except as they may be acceptable for such use when measured by suitable criteria.

Discussion of Some of the Problems Involved in the Study

An investigation of this kind will reveal certain problems and difficulties which must be met. A brief explanation of some of these situations may be valuable.

The first difficulty, as mentioned above, was the writing of implied objectives from the context of some of the sources. This made necessary the adoption of a measure of an objective to be applied to all the objectives written. Every effort was made to have the objectives written from the context of sources fulfil the measure adopted. The objectives stated in other sources often showed a considerable variation in quantitative value. This will be apparent from a study of the table of objectives. In assembling the objectives it was found possible to combine several objectives from a given source into a single objective and thus make it similar to one occurring in another source. It is suggested that in checking the list of objectives against the sources used that this explanation be kept in mind to avoid misinterpretation. In certain cases, there appears to be an omission of some of the context, especially in the textbooks. This is due to the fact that the material referred to may have been mentioned only casually or as illustrative material and not as a text subject, and therefore does not fulfil the measure of an objective.

The use of chapter headings from textbooks as main headings under which the objectives are grouped has been adopted as most convenient. It is justified on the basis of the high degree of standardization of the subject matter of high-school chemistry which seems so apparent. It is suggested that by the adoption of this method of grouping the objectives under the chapter headings, the results will more conveniently serve as reference material. It must not be inferred that the acceptance of the chapter headings, as main headings for grouping the objectives is a justification of the standardization. That is not the purpose of the study.

The curriculum investigations were somewhat disappointing as a source of objectives. Of the objectives written from the sources investigated, only 53 occur in the curriculum investigations used. This lack of tangible material in the investigations dealing with the course of study in high-school chemistry suggests a need for some intensive study in this field. It may be interpreted as an aceeptance without challenge of the context

of the course of study as traditional "handing down" or excerpts from college chemistry.

The limitation of the investigation to six textbooks may seem to be unjustifiable. However, if a study of the texts is made it will be found that in general content there is little variation. To have used a larger number of texts would have greatly increased the bulk of materials and probably would not have enriched the study to any appreciable extent. The opinions of the leaders to whom the tentative list of sources were submitted, indicated that the six books are a fair sample of texts. The occurrence of objectives in terms of life activities is worthy of consideration. The general tone of the sources is in terms of formal content rather than useful activities. Two exceptions to this may be mentioned. These are the Denver course of study and the St. Louis course of study. The field of organic chemistry presents a very definite challenge to curriculum makers. This phase of chemistry full of applications and experiences of daily life is only touched upon in a very general way. In some of the textbooks and courses of study the field of organic chemistry is considered as supplementary material. It is worthy of note that one book[2] although not included in the study does develop chemistry from a different point of view.

Conclusions

Any conclusions which may be formulated from this study will result from an interpretation of the table of objectives. It is not the purpose to do more than suggest one or two outstanding points. The objectives occur in such regular fashion that there seems to be a high degree of standardization in high-school chemistry. The merits of such standardization is not part of the discussion and must be mentioned incidentally. The standardization may suggest either the writing of texts from a basic course or writing courses of study from a review of texts. The limited extent to which specific objectives are found in curriculum investigations is noteworthy. It indicates a lack of qualitative and quantitative investigations of the content of high-school courses of study in chemistry. As a concluding thought one wishes a thorough investigation of the subject matter of high-school chemistry may be conducted as a preliminary work to the writing of a new curriculum.

Sources of Present Specific Objectives in High-School Chemistry

CURRICULUM INVESTIGATIONS

Key Number

1 Beery, P. C., "A Practical Course in Household Chemistry," *Journal of Educational Research*, February, **1922**, pp. 125–34.

2 Harap, H., "The Education of the Consumer," Macmillan, **1926**, pp. 320–4.

[2] Greer and Bennett, "Chemistry for Boys and Girls," Allyn and Bacon, Boston, **1925**.

3 Hopkins, L. T., "A Study of Magazine and Newspaper Science Articles with Relation to Courses in Science for High Schools," *School Science and Mathematics*, November, **1925,** p. 793.

COURSES OF STUDY

11 American Chemical Society, "A Standard Minimum High-School Course in Chemistry," JOURNAL OF CHEMICAL EDUCATION, May, **1924,** p. 87.
12 College Entrance Examination Board, "A Definition of the Requirements in Chemistry," College Entrance Board, 1924.
13 Denver, Colorado, "Course of Study in Chemistry," **1927.**
14 New York State, Department of Education, "Course of Study in Physics and Chemistry," **1926.**
15 North Central Association of Colleges and Secondary Schools, "Report of the Sub-Committee on Chemistry," *North Central Association Quarterly*, March, **1927,** pp. 527-31.
16 St. Louis, Mo., "Chemistry for the High Schools," **1926.**

TEXTBOOKS

21 Bradbury, Robert, "A First Book in Chemistry," Appleton, New York, **1928.**
22 Brownlee, Fuller, Hancock, Sohon, and Whitsit, "Principles of Chemistry," Allyn and Bacon, Boston, **1926.**
24 Dull, Charles, "High-School Chemistry," Holt, **1925.**
26 Gordon, Neil, "Introductory Chemistry," World Book Co., Yonkers-on-Hudson, New York, **1927.**
28 Holmes, H., and Mattern, L., "Elements of Chemistry," Macmillan & Co., New York, **1928.**
29 McPherson, W., and Henderson, W., "Chemistry and Its Uses," Ginn & Co., Boston, **1923.**

TABLE II

PRESENT SPECIFIC OBJECTIVES IN HIGH-SCHOOL CHEMISTRY

An * following a reference number indicates that the material is of a supplementary nature.

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
	Matter and Energy				
1	To know that matter occurs in the form of elements and compounds		12	21, 22, 24, 26, 28, 29	7
2	To be familiar with the qualitative and quantitative measures of energy, heat, light, and electricity		11, 12	22, 24, 29	5
3	To know the electrical theory of matter		13, 15, 16	21, 22, 24, 26, 28, 29	9
4	To know the nature of physical and chemical changes		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
5	To distinguish between physical and chemical properties		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
	Oxygen				
6	To prepare oxygen and study its properties		11, 12, 13, 16, 14	21, 22, 24, 26, 28, 29	11
7	To know how oxygen is prepared commercially		11, 12	22, 24, 26, 28, 29	7
8	To know the uses of oxygen and its relation to life		11, 12, 13, 16, 14	21, 22, 24, 26, 26, 29	11
9	To know the common materials essential to life which contain oxygen		16		1
10	To understand what metals increase in weight when heated in air		16	22	2
11	To understand the several types of combustion and their relation to life. (To know the difference between oxidation and combustion)	1	11, 12, 13, 15	21, 22, 24, 26, 28, 29	11
12	To understand the fire extinguisher and its use	1			1
13	To know the properties of ozone, an allotropic form of oxygen		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
14	To understand the nature of a catalytic agent		11, 12, 13, 16	21, 22, 24, 26, 28, 29	10
	Hydrogen				
15	To prepare hydrogen and study its properties		11, 12, 13, 16, 14	21, 22, 24, 26, 28, 29	11
16	To know how hydrogen is prepared industrially		11, 12	21, 22, 24, 26, 28, 29	8
17	To have a working knowledge of the general methods by which hydrogen is prepared		13, 16, 14	21, 22, 24, 26, 28, 29	9
18	To understand the reaction of certain metals with water and dilute acids		11, 12, 16, 14	21, 22, 24, 26, 28, 29	10
19	To know the uses of hydrogen		11, 12, 13, 16, 14	21, 22, 24, 26, 28, 29	11
20	To know that oils are changed into foods by reaction with hydrogen		11, 12	21, 22, 24, 26, 28, 29	8
21	To know the chemical properties and uses of hydrogen peroxide		11, 12, 13, 14, 16	21, 22, 28, 29	9

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
	Water				
22	To know the composition, physical, and chemical properties of water		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
23	To know the qualitative and the quantitative means of determining the composition of water		11, 12, 13, 14	21, 22, 24, 26, 29	9
24	To know the effect of impurities of water on the health		11, 12, 13, 15	21, 24, 28, 29	8
25	To know the value or importance of various means of purifying water	1	11, 12, 13, 16	21, 22, 24, 26, 29	10
26	To be familiar with the distribution of water in nature		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
	Solutions				
27	To know the nature of a solution and to know the various kinds of solutions		11, 12, 13, 16	21, 22, 24, 26, 28, 29	10
28	To understand and apply the process of crystallization		11, 13, 16		3
29	To know the effect of concentration on the properties of a solution		11, 12, 13	22, 28, 26	6
	Laws and Theories				
30	To know how Charles' Law explains the effect of temperature on a volume of gas		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
31	To know how Boyle's Law explains the effect of pressure on a volume of gas		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
32	To apply the principles of both Charles' and Boyle's laws to solution of problems		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
33	To understand Avogadro's hypothesis as applied in comparing like volumes of gases		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
34	To understand the Atomic Theory		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
35	To understand and apply the Law of Gay-Lussac in the study of combining gases		11, 12, 13, 14, 16	21, 22, 26, 28, 29, 24	11
36	To know the electron theory as applied to chemical reactions		13, 14, 16	26, 28	5

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
37	To understand the Periodic Law as applied to the grouping of elements, and as a means of studying the elements		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
38	To understand Law of Definite Composition		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
39	To know the Law of Multiple Proportions		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
40	To understand the Law of Conservation of Matter and Energy		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
41	To understand the Kinetic Molecular theory of gases		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
	Valence, Formulas, Equation, and Problems				
42	To know the value of molecular weights as a means of expressing quantitative and gravimetric relations		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
43	To be familiar with symbols, formulas, and valence as a means of writing equations		11, 12, 13, 14, 15, 16	21, 22, 24, 26, 28, 29	12
44	To know and use the equation in expressing the four common types of chemical change		11, 12, 13, 16	21, 22, 24, 26, 28, 29	10
45	To know, recognize, and use the symbol and formula as a means of expressing qualitative and quantitative values		13, 16	21, 22, 24, 26, 28, 29	8
46	To know the significance of atomic numbers		14		1
47	To use atomic weights, and molecular weights in the solution of problems of simple chemical calculations		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
48	To understand and use gram-molecular weights, and gram molecular volume in solution of problems		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
	Air or Atmosphere				
49	To know that air is a mixture of gases		11, 12, 13, 16, 14	21, 22, 24, 26, 28, 29	11
50	To know how air is liquefied and to know some of its uses		11, 12, 13, 14, 16	21, 24, 26, 28, 29	10
51	To know the factors which tend to change the composition of the air and those which tend to keep it constant		12	29	2

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
52	To know the occurrence and possible uses of the inert gases of the air			22, 22, 24, 26, 28, 29	6
	Nitrogen				
53	To know that nitrogen occurs freely in the air and is an inactive gas		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
54	To know the importance of the work of bacteria in changing nitrogen of the air into available plant food, and to understand the nitrogen cycle (nitrides)		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
55	To know the uses of nitrogen, in relation to explosives, fertilizers, and dyes		11, 12, 13, 16	21, 22, 24, 26, 28, 29	10
	Nitrogen Oxides				
56	To know the methods of preparing the nitrogen oxides, and to study their properties and uses		11, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
	Nitric Acid and Its Compounds				
57	To know how nitric acid is prepared		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
58	To know the properties and uses of nitric acid (*aqua regia*)		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
59	To know how nitrates are prepared and to study their properties and uses		11, 13	21, 22, 24, 26, 28	7
60	To test for the nitrate ion		11, 12, 16	22, 24, 26, 28	7
	Ammonia				
61	To know the common sources of ammonia and methods of manufacture		11, 12, 13, 14	21, 22, 24, 26, 28, 29	10
62	To prepare ammonia and study its properties and uses		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
63	To test for the ammonium ion Salts of ammonium. See sodium compounds		11, 12, 13, 16	21, 22, 24, 26, 28	9
	Acids, Bases, and Salts				
64	To know the composition and properties of acids		11, 12, 13	21, 22, 24, 26, 28, 29	9
65	To know the composition and properties of bases		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
66	To know the nature of properties and methods of preparing salts		11, 13, 16	21, 22, 24, 26, 28, 29	9
67	To know how acids and salts are named		12, 13, 16	21, 22, 24, 26, 28, 29	9
68	To know the relation of salts to acids		13		1
69	To understand the process of neutralization		11, 12, 13, 14, 15, 16	21, 22, 24, 26, 28, 29	12
	Ionization, Electrolysis				
70	To understand ionization as used in explanation of electrolysis and neutralization		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
71	To know the relation of ionization to chemical activity		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
72	To know why solutions of acids, bases, and salts are electrolytes		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
73	To know how chemical reactions may be accelerated (in solution) and under what conditions a reaction will go to completion		12, 13, 16	21, 22, 24, 26, 28, 29	9
74	To know the difference between an atom and an ion		11, 12, 13, 14, 16	22, 26, 28, 29	9
75	To understand the result of electrolysis		12, 13, 16	21, 22, 24, 26, 28, 29	9
76	To know the changes which take place in electrolysis		13, 16	21, 22, 24, 26, 28, 29	8
77	To know the relation of the charge of the ion to the valence		13		1
	Carbon				
78	To be familiar with the various forms of carbon occurring in nature and to know how these forms may be prepared		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
79	To know the physical and chemical properties of carbon		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
80	To know the uses of the various forms of carbon		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
81	To know the value of the different kinds of fuel	1, 2	11*, 15, 16*,	28	6

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
82	To understand the method of destructive distillation, and to know the valuable commercial products obtained from the distillation of coal and wood		11, 12, 13, 16	21, 22, 24, 26, 28, 29	10
83	To know the sources, chemical properties, and uses of the common hydrocarbons and their derivatives (methane, acetylene, gasoline, naphtha, benzene, turpentine, rubber, chloroform, iodoform, carbon tetrachloride)		11*, 12*, 13, 14, 16	21, 22, 24, 26, 28, 29	11
84	To understand fractional distillation as a means of refining petroleum		11, 12, 13, 14	21, 22, 24, 26, 28, 29	10
85	To know the valuable products obtained from coal tar and their relation to life and industry (benzene, toluene, dyes, drugs, explosives, bakelite, etc.)		13, 14, 16	21, 22, 24, 26, 28, 29	9
	Oxides of Carbon				
86	To prepare carbon dioxide and study its properties		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
87	To know the use of carbon dioxide		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
88	To know that carbon dioxide occurs in the air and to know its relation to animal and plant life		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
89	To test for carbon dioxide and the carbonate ion		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
90	To understand the various kinds of fire extinguishers and their use		11, 12, 13, 16	21, 22, 24, 26, 28, 29	10
91	To know the properties and uses of carbon monoxide		11, 12, 13, 14, 16*	21, 22, 24, 26, 28, 29	11
92	To know the dangers of carbon monoxide gas from automobiles		13	28	2
	Chlorine				
93	To prepare chlorine and study its properties		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
94	To know how chlorine is prepared industrially		11, 12, 13	21, 22, 24, 26, 28, 29	9

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
95	To know the uses of chlorine		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
96	To test for the chloride ion		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
	Hydrochloric Acid				
97	To prepare hydrochloric acid and study its properties and uses		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
	Iodine, Bromine, and Fluorine				
98	To know the uses of iodine in the treatment of goiter		13	28	2
99	To prepare iodine and study its properties and uses		11*, 12*, 13, 14, 16*	21, 22, 24, 26*, 28, 29	11
100	To prepare bromine and study its properties and uses		11*, 12*, 13, 14, 16*	21, 22, 24, 26*, 28, 29	11
101	To prepare the acids of bromine and iodine and know their properties		11*, 12*, 13, 16*	21, 22, 24, 26*, 28, 29	10
102	To become familiar with the hydrogen compounds of the halogens and their corresponding acitivity		13		1
103	To know the properties and uses of fluorine		11*, 12*, 13, 14	21, 22, 24, 26*, 28, 29	10
104	To test for the bromide ion		13, 16	21, 22, 24, 28	6
105	To test for the iodide ion		13, 16	21, 22, 24, 28	6
106	To appreciate the relative activity of the halogens		13		1
	Sulfur				
107	To know the location of American sulfur deposits and the methods of mining		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
108	To prepare allotropic sulfur and know the conditions under which each forms		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
109	To know the physical and chemical properties of sulfur		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
110	To know the uses of sulfur		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
	Sulfur Oxides and Acids				
111	To know how the sulfur oxides are prepared and to know their uses		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
112	To understand how the sulfur acids are prepared and to know their properties and uses		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
113	To identify the sulfate ion		11, 12, 13, 16	21, 22, 24, 26, 28	9
114	To prepare hydrogen sulfide and study its properties		11, 12, 13, 14	21, 22, 24, 26, 28, 29	10
115	To appreciate the importance of sulfur dioxide because of its many uses in the home, in industry and in the community		13		1
	Phosphorus, Arsenic, Antimony, Bismuth				
116	To know the properties and uses of phosphorus and its compounds		11*, 12*, 13, 16*	21, 22, 24, 26, 28, 29	10
117	To know the properties and uses of the arsenic compounds		11*, 12*, 13, 16	21, 22, 24, 26*, 28, 29	10
118	To know the uses of the compounds of antimony and bismuth		11*, 12*, 13, 16	21, 22, 24, 26*, 28, 29	10
119	To know the use of phosphorus, arsenic, antimony, and bismuth as alloying agents		11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
	Silicon and Boron				
120	To know the source, properties, and uses of silica, SiO_2	1	11*, 12*, 13, 16*	21, 22, 24, 26, 28, 29	11
121	To know the uses of quartz in producing ultra-violet rays			28	1
122	To know the value of borax as a water softener		13, 16	21, 22, 24, 26, 28, 29	8
123	To know the value of boric acid as an antiseptic	2	13, 16	21, 22, 24, 26, 28, 29	9
	Metals				
124	To know the difference between a metal and a non-metal		11, 12, 13, 16	21, 22, 24, 26, 29	9
125	To understand the displacement of metallic ions from solution by certain other metals, *i. e.*, the electromotive series		11*, 12, 16	21, 22, 24, 26, 28, 29	9
126	To know the general methods of extracting metals from ores		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
127	To know in what compounds the metals occur		11, 12, 13	22, 24, 26, 28, 29	8
128	To know the effect of air, water, and acids on metals		11, 12, 16	22, 24, 26, 29	7
129	To know the cause of the activity of metals		13, 16	26	3
130	To know the four common methods of preparing metallic salts		11, 13, 16	24, 26, 29	6
131	To know the nature, properties, and uses of metal alloys		11*, 12, 13, 14	21, 22, 24, 26, 28, 29	10
132	To know the cause of rust and methods of preventing it		13		1
133	To detect the common metallic ions in solution		13		1
134	To know the nature and importance of catalysis		11, 13, 14, 16	21, 22, 24, 26, 28, 29	10
135	To know that certain metals such as gold, silver, etc., occur in free state		13		1
	Sodium and Potassium				
136	To know how sodium and potassium are prepared and to study their properties		11Na, 12 Na, 13, 14 Na, 16Na	21, 22, 24, 26, 28, 29	11
137	To know methods of preparation, properties, and uses of the common compounds of sodium and potassium		11Na, 12 Na, 13, 14 Na, 16Na	21, 22, 24, 26, 28, 29	11
138	To know that water glass is used in preserving eggs	2	(Included in No. 145)		1
139	To know the properties and uses of the common ammonium compounds		13, 14, 16	21, 22, 24, 26, 28, 29	9
140	To guard against the effect of caustic alkalies and the irritation of ammonia on the sensitive membranes	2			1
	Calcium				
141	To be familiar with the occurrence, properties, and uses of calcium carbonate		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
142	To know the methods of preparation, properties, and uses of the more common calcium compounds		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
143	To know the value of calcium compounds as a fertilizer		11*, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
144	To know the economic importance of hard water and to understand the means of softening	1	11, 13, 14, 16	21, 22, 24, 26, 28, 29	11
145	To keep a continuous stock of lime and to use it as a fertilizer, deodorizer, insecticide, and in mortar and plaster	2			1
146	To make and apply putty	2			1
147	To know the value of cement in construction of roads, steps, driveways, and buildings	2			1
148	To be familiar with common names, lime, slaked lime, cement, mortar, stucco, plaster of Paris, alabaster, and gypsum		13		1
	Magnesium				
149	To know the properties of magnesium and its alloys		11, 12, 14, 16	21, 22, 24, 26, 28, 29	10
150	To know the uses of the more common magnesium compounds		11*, 16	21, 22, 24, 26, 28, 29	8
	Iron and Its Compounds				
151	To know the methods of producing cast iron and steel		11, 12, 13, 14, 16	21, 22, 24, 26, 28, 29	11
152	To know the properties of cast iron and steel and to know the effect of impurities and alloying agents on the properties	2	11, 12, 13	21, 22, 24, 26, 28, 29	10
153	To know the uses of various kinds of iron and steel	2	11, 12*, 13	21, 22, 24, 26, 28, 29	10
154	To know the method and importance of tempering steel		13	21, 22, 24, 26, 28, 29	7
155	To know the means of protecting iron and steel from corrosion		11, 12, 13, 16	21, 22, 24	7
156	To understand oxidation and reduction in terms of ferrous and ferric compounds		11, 12, 13, 16*	21, 22, 24, 26, 28, 29	10
157	To know the uses of iron compounds		11, 13, 16	21, 22, 24, 26, 28, 29	9
158	To test for the ferrous ion and the ferric ion		11, 12, 13	21, 22, 24, 26, 28, 29	9

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
159	To distinguish between cast iron, malleable iron, and steel, the metals of which tools are commonly made	2	13		2
160	To know that iron compounds are used in making blue prints		13, 16	21, 22, 24, 28, 29	7
161	To know how to remove ink stains		13, 16	21, 22, 24, 28, 29	7
	Aluminum				
162	To understand the electrolytic process of extracting aluminum		11, 13, 16	21, 22, 24, 26, 28, 29	9
163	To know the properties of aluminum		11, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
164	To know the uses of aluminum and its alloys		11, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
165	To know the properties of aluminum hydroxide and aluminum sulfate and to know their use in water purification and dyeing	2	11, 13, 16	21, 22, 24, 26, 28, 29	10
166	To understand the chemical nature, properties, and uses of portland cement	2	11, 12*, 13, 16	21, 22, 24, 26, 28, 29	11
167	To know the value of clay in manufacture of dishes and pottery	2	11, 12*, 13, 16	21, 22, 24, 26, 28, 29	11
168	To test for aluminum in solution		13		1
	Copper				
169	To understand the electrolysis of copper as applied in the purification of the element and in electroplating		11, 12*, 13, 14, 16	21, 22, 24, 26, 28, 29	11
170	To know the properties and uses of copper and its alloys		11, 12*, 13, 14, 16	21, 22, 24, 26, 28, 29	11
171	To select brass or bronze for door knobs, hinges, windows catches, and plumbing fixtures	2			1
172	To know the importance of copper sulfate as an insecticide and fungicide		11, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
	Zinc				
173	To know the properties and uses of zinc		11*, 13*, 13	22, 22, 24*, 26, 28, 29	9
174	To know the properties and uses of the zinc compounds		11*, 12*, 13	21, 22, 24*, 26, 28, 29	9
175	To test for zinc		13		1

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
	Mercury				
176	To know the properties and uses of mercury		11*, 12*, 16*	21, 22, 24, 26, 28, 29	9
177	To know the importance of the compounds of mercury		11*, 12*, 16*	21, 22, 24, 26, 28, 29	9
178	To know that alloys of mercury are called amalgams and to know the uses of amalgams		13, 16		2
	Tin				
179	To know the properties and uses of tin and its compounds			22, 21, 24, 26, 28, 29	6
	Lead				
180	To know the properties and uses of lead and its compounds		11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
181	To know the chemistry of the storage battery		13, 16	26, 28, 24	5
182	To test for lead in solution		13, 16		2
	Silver				
183	To know the properties and uses of silver		11*, 12*, 13	21, 22, 24, 26, 28, 29	9
184	To know the chemistry of photography		11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
185	To test for the silver ion		13		1
	Gold				
186	To know the properties and uses of gold		11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
187	To know the methods of extraction		13		1
	Radium				
188	To know the nature of radium disintegration and its importance in relation to chemical activity and life		11*, 15	21, 22, 24, 26*, 28, 29	8
	Less Common Elements				
189	To know the uses of some of the less common metals, chromium, cerium, molybdenum, nickel, platinum, thorium, tungsten, and selenium			21, 22, 24, 26, 28, 29	6
	Organic Chemistry				
190	Hydrocarbons and derivatives	See carbon and its compounds			
191	To know the source, properties and use of the carbohydrates (sugars and starch), and their relation to life		13, 15, 16	21, 22, 24, 26, 28, 29	9

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
192	To test for sugars		13, 16		2
193	To know the chemical nature of organic acids, their occurrence, and uses		11, 15, 16	21, 22, 24, 26, 28, 29	9
194	To know how alcohols are prepared, and to know the nature, properties, and uses (methyl, ethyl)		11, 13, 15, 16	21, 22, 24, 26, 28, 29	10
195	To prepare and study the properties and uses of esters (occurrence in nature)		11, 13, 15, 16	21, 22, 24, 26, 28, 29	10
196	To know the source and chemical constituents of the common foods (vitamins included)		11*, 12*, 13, 14, 15, 16	21, 22, 24, 26, 28, 29	12
197	To know how textiles are bleached and dyed	1, 2	13, 16	21, 22, 24, 26, 28, 29	10
198	To know and identify silks weighted with metals	2			1
199	To know materials from which paper is made and distinguish various grades of paper	2	(See cellulose)		1
200	To know the chemical nature of textiles and their relation to clothing	1, 2	11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	12
201	To know the composition and properties of cosmetic preparations and to guard against injurious materials	2			1
	Miscellaneous Group				
202	To know the value of various germicides and antiseptics	2			1
203	To be familiar with the common poisons and drugs and understand first aid in poison cases	2			1
204	To use disinfectants	2			1
205	To guard against the poisonous effect of bichloride of mercury and phenol in antiseptics	2			1
	Paints, Varnish, and Driers				
206	To be familiar with the nature and use of various paints and varnishes	1, 2	11*, 13, 16	21, 22, 24, 26, 28, 29	11
207	To be familiar with paint driers and thinners, turpentine and benzol	2		21, 22, 24, 29	5
208	To guard against the effect of methyl alcohol on the eyes in the use of shellac and varnish	2			1

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
209	To know the poisonous effects of lead and mercury compounds in paint	2			1
210	To know the value of various paint ingredients for indoor and outdoor use	2			1
211	To know the protective value of paint	2			1
212	To know foods rich in carbohydrates, fats, proteins, and mineral salts	2			1
213	To learn the nature and function of enzymes		13, 16	21, 22, 24, 26, 28, 29	8
214	To know the nutrient value of milk	2		21, 22, 24, 26, 28, 29	7
215	To know the constituents of oleo-margarine and its relation to butter as a food	2			1
216	To know the methods of food preservation and the value of food preservatives, in their relation to health	2	11*, 13, 15, 16	29	6
217	To know and detect adulterants which affect life	2	13, 16		3
218	To know the value of coal-tar derivatives, in medicine, foods, dyes, and explosives		11*, 13, 16	21, 22, 24, 26, 28, 29	9
219	To know how soap is prepared and to study the properties and uses of various kinds of soap	1, 2	11*, 12*, 13, 14, 16	21, 22, 24, 26, 28, 29	13
220	To know and identify adulterated soaps	2			1
221	To select good medicated and toilet soaps	2			1
222	To make cleaning and polishing preparations which consist of simple solutions sold under trade names	2			1
223	To know the use of acids, alkali, and organic solvents as cleaning agents	2	11*, 13, 14, 15, 16	21, 22, 24, 26, 29	11
224	To know how to remove stains from metals, fabrics, and other surfaces	1, 2	13, 15, 16	29	6
225	To know the nature and value of explosives		11*, 13, 15, 16	21, 22, 24, 26, 28, 29	10
226	To know the use of cellulose and its derivatives		11*, 13, 15 16	21, 22, 24, 26, 28, 29	10
227	To know the source of common dyes and their correct use	1, 2			2
	Adhesives				
228	To know the composition and value of common adhesives, glues, and cements	2			1
229	To make such adhesives in the home as can be simply prepared	2			1

No.	Objective	Curriculum investigation	Courses of study	Textbooks	Total
	Colloids				
230	To know how colloids are prepared		11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
231	To know the nature of colloids		11*, 12*, 13, 16*	21, 22, 24, 26, 28, 29	10
232	To know the relation of colloids to life and industry		11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
233	To know and recognize the common colloids (smoke, fog, glue, cement, gelatin, rubber, etc.)		11*, 12*, 13, 16	21, 22, 24, 26, 28, 29	10
234	To know and use correctly terms explanatory of colloidal phenomena (emulsion, gel, sol, protective colloid, adsorption, suspension)		11*, 12, 13, 16	21, 22, 24, 26, 28, 29	10
235	To know the value of anesthetics		15		1
		55	742	1438	1805

Magic Lantern Measures Photographic Plates. A stereopticon, or "magic lantern" and a photoelectric cell, which converts light to electricity, are the chief parts of a simple apparatus for measuring photographic plates described recently by Dr. Cedric E. Hesthal and Dr. George R. Harrison of Stanford University at the meeting of the American Physical Society and the Pacific Division of the American Association for the Advancement of Science.

The device is used in such researches as those of spectroscopy, where it is necessary to measure the intensity of a series of dark lines crossing the plate. The plate is put in the stereopticon in place of the slide, and moved along so that its image on the screen passes across a small slit. Back of the slit is the photo-electric cell, connected with current measuring apparatus, arranged to plot the current changes as a curve. This curve corresponds to the intensity changes of the lines.—*Science Service*

Sunlight Affects Plants' Use of Mineral Salts. Plants need comparatively minute amounts—often mere traces—of certain elements such as boron, zinc, copper, and manganese, in addition to the larger quantities of the more familiar things such as phosphorus, potassium, and calcium. The quantities of these "trace minerals" that will benefit any given plant seem to be governed by the intensity of the sunlight under which it is growing, according to Dr. Winifred E. Brenchley of the great British agricultural laboratory at Rothamstead, who spoke recently before the meeting of the British Association for the Advancement of Science at Cape Town, South Africa.

Too bright sunlight appears to increase the harm done by the absence of some of these lesser elements, Dr. Brenchley said. One somewhat puzzling practical aspect of the problem has been that the benefits of copper applications to peat soils in Florida, a treatment much used in the truck-farming regions, cannot be duplicated by similar treatment of peat soils in England.—*Science Service*

SIMPLIFIED METHODS FOR SOLVING AND FORMULATING PROBLEMS IN INDIRECT ANALYSIS

EARLE R. CALEY, PRINCETON UNIVERSITY, PRINCETON, NEW JERSEY

The task of computing or formulating problems in indirect analysis is one that consumes considerable time in calculation if the usual algebraic method of solution is followed. The time taken in such computations is especially felt when checking or formulating a series of such problems for student use. The writer has found that a short arithmetical method may be substituted for the usual algebraic solution in handling this type of analytical problem. In order to show the greater simplicity of the method as compared to the algebraic solution, as well as to show the principle of the method, the two types of solution are given below as applied to specific problems under the two general cases that occur in indirect analysis.

Case I

General Statement: Two different elements united to a common element or radical are weighed together and then the amount of the common element or radical is estimated in a suitable manner. From the weight of the mixture and the weight of the common element found, the percentages or weights of the two components of the mixture are computed.

Specific Problem: A residue of potassium chloride and sodium chloride weighed 0.2230 gram. The total chlorine in the residue was determined gravimetrically and was found to amount to 0.1285 gram. Find the percentage of each chloride present in the mixture.

USUAL METHOD OF SOLUTION	STEPS
Let x equal the weight of NaCl present And $0.2230-x$ the weight of KCl present	1
Then $\frac{35.5}{58.5}x + (0.2230-x)\frac{35.5}{74.6} = 0.1285$	2
$0.6068x + (0.2230-x)(0.4759) = 0.1285$	3
$0.6068x + 0.1061 - 0.4759x = 0.1285$	4
$0.1309x = 0.0224$	5
$x = 0.1711$	6
$\frac{0.1711}{0.2230} \times 100 = 76.72\%$ NaCl	7
$100.00-76.72 = 23.28\%$ KCl	8

SHORTENED METHOD OF SOLUTION	STEPS
1. If the residue consisted of pure NaCl the amount of Cl found would be: $0.2230 \times \frac{35.5}{58.5} = 0.1353$ gram	1
2. If the residue consisted of pure KCl the amount of Cl found would be: $0.2230 \times \frac{35.5}{74.6} = 0.1061$ gram	2

3. Then the difference between the amount of Cl found and the amount that could theoretically be present if the residue consisted of only the first component, divided by the total possible range of Cl, multiplied by 100 gives the percentage of the second component:

$$\frac{0.1353-0.1285}{0.1353-0.1061} \times 100 = 23.28\% \text{ KCl} \qquad 3$$

4. And

$$100.00-23.28 = 76.72\% \text{ NaCl} \qquad 4$$

Case II

General Statement: Two different elements united to a common element or radical are weighed together. The original mixture is then converted into a second mixture which contains the two elements united to a different common element or radical. From the weights of the two mixtures the percentages or weights of the components of the original mixture are computed.

Specific Problem: A mixture of calcium oxide and strontium oxide weighed 0.3200 gram. When evaporated with sulfuric acid and weighed again as the sulfates the weight was found to be 0.6511 gram. Find the percentage of each oxide in the original mixture.

USUAL METHOD OF SOLUTION	STEPS
Let x equal the weight of CaO present And $0.3200-x$ the weight of SrO present	1
Then $\frac{136.15}{56.1}x + (0.3200-x)\frac{183.65}{103.6} = 0.6511$	2
$2.4269x + (0.3200-x)(1.7727) = 0.6511$	3
$2.4269x + 0.5673-1.7727x = 0.6511$	4
$0.6542x = 0.0838$	5
$x = 0.1281$	6
$\frac{0.1281}{0.3200} \times 100 = 40.03\%$ CaO	7
$100.00-59.97 = 59.97\%$ SrO	8

SHORTENED METHOD OF SOLUTION	STEPS
$0.3200 \times \frac{136.15}{56.1} = 0.7766$	1
$0.3200 \times \frac{183.65}{103.6} = 0.5673$	2
$\frac{0.7766-0.6511}{0.7766-0.5673} \times 100 = 59.97\%$ SrO	3
$100.00-59.97 = 40.03\%$ CaO	4

In the above shortened solution the same principles are followed as in Case I; *i. e.*, the weights of the sulfates that would be obtained if the original mixture consisted of either pure oxide are first found, and then the difference between the actual given weight of mixed sulfates and the theo-

retical weight of the sulfate if only the first oxide was present, divided by the total possible range in the weight of the sulfates multiplied by one hundred, gives the percentage of the second oxide in the given mixture.

It is apparent, then, that this type of solution is general for problems in indirect analysis since the amount of the common element found or the weight of a second mixture containing a common element lies somewhere between certain possible limits and its position within these limits is a linear function of the percentage composition of the given mixture. The general method involved in this shortened solution is to calculate first the possible limits in a problem and then from the position of the given quantity within these limits compute the composition of the given mixture by simple proportion.

Further Applications

This method can also be extended to those problems in which the weight of the common element is given in terms of the weight of precipitate obtained in its determination or in the volume of standard solution consumed in its estimation, as the following example shows.

Example 1: A mixture of NaCl and KCl weighed 0.2550 gram. The total chloride in the sample was determined by titration with tenth-normal silver nitrate, 40.1 cc. being required. Find the percentage of each chloride in the mixture.

Solution:

$$0.2550 \times \frac{35.5}{58.5 \times 0.00355} = 43.6$$

$$0.2550 \times \frac{35.5}{74.6 \times 0.00355} = 34.2$$

$$\frac{43.6-40.1}{43.6-34.2} \times 100 = 37.2\% \text{ KCl}$$

$$100.0-37.2 = 62.8\% \text{ NaCl}$$

There are also certain types of problems in indirect analysis which, at first glance, do not appear to belong to either of the two general classes mentioned above. These almost invariably can be grouped under one of the above general cases upon closer inspection, and in any event they can be solved by the proportional method. The following example is illustrative.

Example 2: Given a mixture of potassium chloride and potassium sulfate weighing 0.2500 gram. The mixture was converted entirely to potassium sulfate by evaporation with sulfuric acid and the weight of pure potassium sulfate obtained was 0.2615 gram. Find the percentage of potassium chloride present in the original mixture.

Solution: On inspection this is seen to be an example coming under Case I since two different groups are united to a common element, which is

estimated in a form which happens to be identical with one of the constituents of the original mixture. The proportional solution is simple.

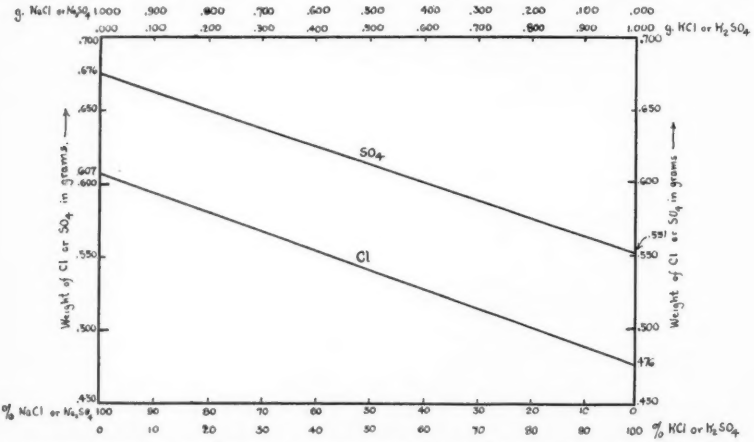
$$0.2500 \times \frac{174.2}{149.2} = 0.2921$$

$$\frac{0.2615-0.2500}{0.2921-0.2500} \times 100 = 27.4\% \text{ KCl}$$

Thus the proportional method of solution is seen to be applicable to all types of problems in indirect analysis regardless of their form and is to be preferred to the algebraic method of solution on the bases of brevity and simplicity.

The Graphic Solution of Problems in Indirect Analysis

A graphic solution of problems of this nature, based upon the same principles used in the above-described short numerical method, is even of



ILLUSTRATIVE GRAPH SHOWING COMPOSITION OF ALL POSSIBLE MIXTURES OF EITHER THE CHLORIDES OR THE SULFATES OF SODIUM AND POTASSIUM FOR USE IN CHECKING SOLUTIONS OF PROBLEMS IN INDIRECT ANALYSIS. BASED UPON A ONE-GRAM SAMPLE

greater convenience for rapidly checking a series of such problems for correctness of solution or formulation. The accompanying figure shows a graph adapted to mixtures of the chlorides or sulfates of sodium and potassium. The method of construction and use is evident from the figure. When the weight of the mixture differs from one gram it is then necessary to multiply the graphic values by the sample weight or to convert the given values to the one-gram basis. It is apparent that separate graphs must be drawn for the different mixtures that are to be considered. To be of any value such graphs must be drawn accurately and be of ample size.

They are not to be recommended for the purpose of solving problems in indirect analysis, but simply as a means of rapidly checking solutions or formulations of such problems.

Conclusion

The graphic method described above is rather to be regarded as a teacher's aid than as a method for student use, but the short numerical method given in this paper is to be recommended for the use of both the teacher and the student of quantitative analysis. From the teacher's viewpoint, in addition to time saved in calculation, this proportional method simplifies the matter of formulating new problems in indirect analysis or forming variations on the same problem, since the effect of altering the quantity of the common element or the second mixture is readily calculated from the given proportion. For the student it is simpler and shorter than the usual algebraic method of solving problems in indirect analysis.

Deaths from Leaky Refrigerators Small Compared with Number in Use. Despite the deaths from methyl chloride leaking from automatic refrigerators in various parts of the country, these iceless cooling machines do not form a very serious menace to life and health. This is the substance of a joint report recently issued by the U. S. Public Health Service, the Bureau of Standards, and the Bureau of Mines. In fact, the great majority of the electric- and gas-fired refrigerators in the homes make use of ammonia or sulfur dioxide, in the coils of the machine.

"None of the three refrigerants mentioned, ammonia, sulfur dioxide, or methyl chloride, can be breathed with impunity, but none are violent poisons when breathed for a short time in low concentrations," says the report. "If the same amount of the three substances is considered, methyl chloride is the least poisonous of the three; but because their physiological effects are quite different it is hard to make a quantitative comparison. Sulfur dioxide and ammonia both have strong odors which are easily recognized and are so irritating that no one is likely to breathe much of them if escape is possible. Methyl chloride has a slight and rather pleasant odor, which would probably not awaken a sleeping person and might not be recognized by one who was awake. To this fact can be attributed any greater hazard from methyl chloride than from other commonly used refrigerants."

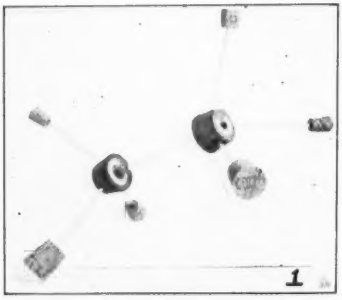
The report emphasized that the gas used as a refrigerant has nothing to do with the fuel gas used to run certain types of refrigerator. In all types in which a flame of illuminating gas is used to heat the refrigerant, the latter is ammonia. In most of the electric types, where a motor compresses the refrigerant, sulfur dioxide is used, though a few makes use methyl chloride. It is only the latter that presents any danger, especially where used in a large plant to supply a number of apartments.

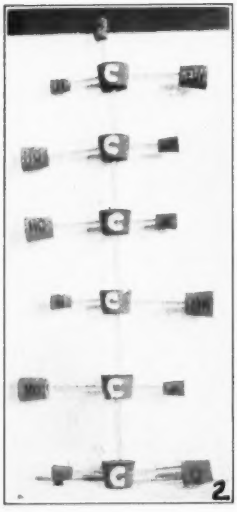
Addition of a smelly gas to the nearly odorless methyl chloride may be one means of preventing further accidents of this nature. Other remedies suggested are the entire replacement of methyl chloride with less dangerous gases, or the mechanical improvement of the refrigerating systems so that the gas will not leak into rooms in which people sleep.—*Science Service*

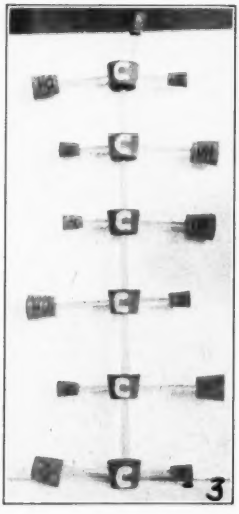
MOLECULAR MODELS IN ORGANIC CHEMISTRY

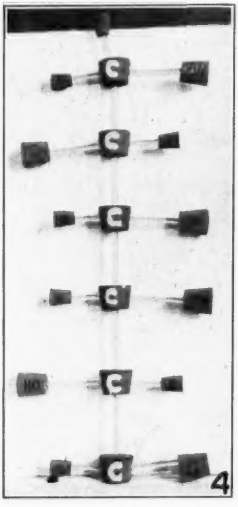
N. MINNÉ, ST. OLAF COLLEGE, NORTHFIELD, MINNESOTA

Students in elementary organic chemistry frequently have trouble in visualizing formulas of compounds which are optically active. To represent, on the plane surface of a blackboard, the spatial configuration of a molecule whose carbon atoms may be asymmetric is not always an easy task for the teacher. This difficulty is often encountered in the study of tartaric acid. In order to show more clearly the arrangement of the (CO-OH), (OH), and (H) groups, the writer found it helpful to make use of a simply constructed model of tartaric acid, appearing in photograph (1).









It is made of stoppers, corks, and glass rod, found in every laboratory. Number 7 stoppers were used to represent the asymmetric carbon atoms, and these were fitted with glass rods to indicate the valences. Corks of different sizes were used to show the difference between the masses of the groups. It suggests itself immediately that a simple shifting of the corks in the

original *d*-tartaric model will produce a model representing the *l*-tartaric acid, or the meso-tartaric acid.

It was also found helpful to make use of a model constructed similarly, in the study of carbohydrates. The four asymmetric carbon atoms of dextrose can thus be shown clearly (2). By turning the stoppers representing the asymmetric carbon atoms about the central axis, it is possible to illustrate the formula of the 16 isomeric aldohexoses. The reverse side of the dextrose model represents the *levo*-glucose molecule (3). The formula for galactose can be illustrated by turning the third stopper about its axis (4). The relationship between dextrose and levulose can also be shown, for the rods representing the doubly linked oxygen can be removed, and a ketohexose can be constructed.

Other teachers may find this simple expedient of value in instruction in organic chemistry.

Zinc Sulfide Paint and Phototropy. A man's puzzlement over a fence post which he had painted black but which turned white every night was the starting point of a program of research which has culminated in the discovery of a number of chemicals having this remarkable chameleon-like property scientifically termed phototropy. Information regarding these chemicals has now been made public by the American Chemical Society.

The famous fence post was painted with a "pigment having a zinc basis." It would turn black soon after sunrise each morning, only to turn white again when darkness came. Many explanations have been given for the phenomenon, but scientists are not agreed as to the cause of it. They have, however, found several other substances besides the zinc sulfide, which was in the paint on the post, that will also change color with the light.

Most of the known phototropic liquids are solutions of colorless derivatives of certain dyes. The solutions are practically colorless in the dark but turn the color of the parent dye when exposed to light.—*Science Service*

Living Organisms Act as Radium Concentrations. Radium, in almost infinitesimal amounts, is to be found in all living plants and animals. It is gathered up by them and concentrated from its even thinner distribution in natural soils and waters. This is the claim advanced by Prof. V. J. Vernadsky, member of the Russian Academy of Sciences, after investigations conducted at the Russian State Radium Institute and the Biogeochemical Laboratory.

Surface water from a freshwater pond tested at the laboratory showed the presence of radium in almost inconceivably small amounts. Its concentration would be represented by the fraction 68,100,000,000,000,000, or 68 one-hundred-trillionths of one per cent. A sample from a deeper part of the pool contained somewhat more.

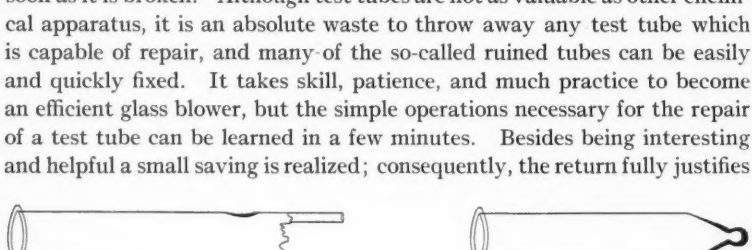
But two species of floating duckweed scooped off the pond's surface showed the presence of 39 one-hundred-billionths of a per cent of radium, or over 56 times as great a concentration as was found in the water: and this in spite of the fact that over 90 per cent of the plant itself consists of water. Different species were found to have characteristic concentrations of radium peculiar to themselves.

Tests of land plants and water animals showed rather less radium than was present in the water plants. In them the average concentration was of the order of one one-hundred-billionth of one per cent.—*Science Service*

A SIMPLE METHOD FOR REPAIRING BROKEN TEST TUBES

LOUIS S. KEYSER, WHITWORTH COLLEGE, SPOKANE, WASHINGTON

It is a common thing in the average laboratory to discard a test tube as soon as it is broken. Although test tubes are not as valuable as other chemical apparatus, it is an absolute waste to throw away any test tube which is capable of repair, and many of the so-called ruined tubes can be easily and quickly fixed. It takes skill, patience, and much practice to become an efficient glass blower, but the simple operations necessary for the repair of a test tube can be learned in a few minutes. Besides being interesting and helpful a small saving is realized; consequently, the return fully justifies



the time and labor spent. The following method applies only to those test tubes which have had the end knocked out or broken off.

The broken end of the tube is first fused with a piece of scrap tubing. This can be done by holding the two ends in a flame until the ends are a bright cherry red. They are then pressed quickly together and allowed to cool. The next step consists of heating the test tube about one-half inch from the point of fusion or just above the last part of the break. The tube should be rotated in the same spot until it begins to contract (1). It will become thick and it should be allowed to draw itself slowly apart, so that the glass at the end becomes thicker than that of the rest of the tube. After a bit the tube will become very narrow and will melt in two (2).

The tube is then allowed to cool and the small piece of solid glass at the end of the tube is filed off so as to leave less glass to be ironed out later (3). The tube should be rotated continually while in the flame.

The tube is now slowly reheated by putting only the small tip in a remote part of the flame. This precaution must be taken in order to insure against breaking the tube by too fast reheating and thereby ruining an otherwise good job. Heating the point also serves to close any possible hole which might have resulted from the filing operation. When the point and about an eighth of an inch of the tube are red, the tube is taken to the mouth and gently blown so that the globule which forms on the end is partly removed (4). Too much blowing at this point will force out the end too far, and the glass will either burst or become too thin to be manageable. The point is again placed in the flame and rotated. This is continued until the point has contracted back to where it was before the blowing. The tube is then removed and blown. Only a very light pressure should be used. This step should be repeated three or four times or until all of the original globule at the end has been absorbed. A little more of the tube may be heated each time the step is repeated (5).

The tube is again heated, this time with the entire end in the flame. When the entire end is bright red, the tube is held in a vertical position and blown until the end is rounded out (6). Great pains should be taken not to blow too hard. Too much pressure will result in a large end which is very difficult to remove.

If the above steps are carried out, the test tube will have an end which is as strong if not stronger than that of the original tube. With practice the operator can become expert enough to make a repair which defies detection as a piece of mended work. Remember that continuous rotation of the tube and gentle blowing are essential to good work.

Moonlight Shadow Caught by Chemist. Demonstrating the much-mooted effect of moonlight on starch by means of a chemical trap to catch a shadow was the feat reported at Capetown, South Africa, before the meeting of the British Association for the Advancement of Science by Miss E. Semmens of Bedford College, London. Miss Semmens has for some years been studying the effect of polarized light on starch solutions, which it is claimed are turned into sugar by prolonged exposure. Moonlight is composed largely of polarized sunlight, and it might be expected that it would have an effect on suitably prepared starch.

Miss Semmens dipped slips of paper into starch solutions and exposed them to moonlight, covering parts of them with small opaque objects to cast shadows. Then she dipped the paper into an iodine solution, which as is well known turns starch black but leaves sugar colorless. Where the shadow had fallen, there was a faint but distinguishable deepening of the color, indicating that sugar had been formed in the uncovered part. She was also able to repeat the same test with leaves containing starch grains.—*Science Service*

THE MINNEAPOLIS MEETING

REPORT OF THE SECRETARY OF THE DIVISION OF CHEMICAL EDUCATION

The meeting of the American Chemical Society at Minneapolis, Minnesota, September 9–13, 1929, was a memorable one. The weather, the program of papers, and the entertainment combined to make it most successful.

The program of the Division of Chemical Education, as announced in the September issue of the JOURNAL, pp. 1555–6, was carried through with few changes. In addition to the papers listed in that announcement, the following were presented:

WM. MCPHERSON—Chairman's Address.

J. H. REEDY—"An Experiment in Segregating Chemistry Students According to Their Professional Interests."

WM. F. EHRET—"Teaching Inorganic Chemistry to Thousands."

ROSALIE M. PARR AND MABLE A. SPENCER—"Should Laboratory Work or Recitation Have Precedence in the Teaching of High-School Chemistry?"

HENRY P. HOWELLS—"Aldol Condensation as a Tool in the Teaching of Organic Chemistry."

O. F. STAFFORD—"Concerning the Future of the One-Year Course in Chemistry."

Great interest was shown in the Symposium on Selecting the Chemist-Elect, at which representatives of industrial organizations stressed the fundamental training and qualifications which they consider most important. A large number participated in the discussion, which was led by Irving Langmuir of the General Electric Company, G. S. Rutherford of the Western Electric Company, W. J. Marsh of the Hooker Electrochemical Company, Wm. J. Hale of the Dow Chemical Company, G. J. Esselen, Jr., of Skinner, Sherman, and Esselen, Incorporated, and F. W. Blair of the Procter and Gamble Company. Over three hundred were present at this symposium.

A delightful feature of the program was a luncheon complimentary to the high-school teachers of the area and to a number of other guests. Following the luncheon short addresses were given by the Hon. W. F. Kunze, Mayor of Minneapolis, Dr. C. A. Prosser, Director of Dunwoodie Institute, and the Hon. J. M. McConnell, Commissioner of Education, State of Minnesota. Dr. William McPherson, as chairman, then introduced other guests as follows:

Dr. G. S. Perez, Director of Vocational Education, Manila, P. I.; Dr. James Kendall, Professor of Chemistry, University of Edinburgh; O. M. Leland, Dean of the College of Engineering, and Dr. S. C. Lind, Director of the Department of Chemistry of the University of Minnesota; Dr. Irving Langmuir, *president*, and Dr. Charles L. Parsons, *secretary*, of the American Chemical Society; Dr. Max Bodenstein, Professor and Director of Physical Chemistry Instruction, University of Berlin; Dr. K. F. Bon-

Status of Chemistry Teaching in Sixty-Nine State T

Institution	Location	Instructors and Degrees	
		Highest degr	
		Ph.D.	A.M.
S. N. S.	Florence, Ala.	0	1
S. N. S.	Jacksonville, Ala.	0	1
North. S. T. C.	Flagstaff, Ariz.*	1	0
S. T. C.	Conway, Ark.	0	1
S. T. C.	Chico, Calif.	0	1
S. T. C.	Fresno, Calif.	2	1
S. T. C.	San Diego, Calif.	1	1
S. T. C.	Santa Barbara, Calif.*	0	2
S. T. C.	San Jose, Calif.	0	2
S. T. C.	San Francisco, Calif.	1	1
S. T. C.	Greeley, Colo.*	1	0
West. S. T. C.	Gunnison, Colo.*	1	0
S. N. S.	New Haven, Conn.	0	0
(No separate)	State of Delaware	–	–
(No separate)	State of Florida	–	–
S. T. C.	Athens, Ga.	0	1
S. N. S.	Lewiston, Idaho	0	0
North. S. T. C.	DeKalb, Ill.*	0	1
S. Normal Univ.	Normal, Ill.	0	3
S. N. S.	Terre Haute, Ind.*	0	2
Ball T. C.	Muncie, Ind.*	0	1
S. T. C.	Cedar Falls, Iowa*	0	2
S. T. C.	Emporia, Kan.*	0	1
S. N. & T. C.	Morehead, Ky.	0	0
East. S. T. C.	Richmond, Ky.*	0	1
S. N. C.	Natchitoches, La.*	0	1
S. N. S.	Farmington, Maine	0	0
S. N. S.	Towson, Md.	0	0
S. N. S.	Framingham, Mass.	1	0
S. N. S.	Salem, Mass.	0	0
West. S. T. C.	Kalamazoo, Mich.*	1	1
North S. T. C.	Marquette, Mich.	0	2
Cent. S. T. C.	Mount Pleasant, Mich.*	0	1
S. N. C.	Ypsilanti, Mich.*	0	2
S. T. C.	Mankato, Minn.	0	0
S. T. C.	St. Cloud, Minn.	0	0
S. T. C.	Hattiesburg, Miss.	0	1
Cent. S. T. C.	Warrensburg, Mo.*	1	0
S. E. S. T. C.	Cape Girardeau, Mo.*	0	1
S. W. S. T. C.	Springfield, Mo.*	0	1
S. N. C.	Dillon, Mont.	0	0
S. N. & T. C.	Peru, Nebr.	0	1
S. N. & T. C.	Kearney, Nebr.	0	0
(No separate)	State of Nevada	–	–
S. N. S.	Newark, N. J.	0	0
S. N. S.	Keene, N. H.	0	0
Normal Univ.	East Las Vegas, N. Mex.	0	0
S. T. C.	Albany, N. Y.*	0	2
S. T. C.	Buffalo, N. Y.*	0	2
S. N. & Train'g	Oswego, N. Y.	0	0
S. N.	Cullowhee, N. C.	0	0
S. T. C.	Valley City, N. D.*	0	0
S. N. Coll.	Bowling Green, Ohio	1	0
E. Cent. S. T. C.	Ada, Okla.*	0	1
Cent. S. T. C.	Edmond, Okla.*	0	1
S. T. C. South.	Ashland, Ore.	0	0
S. T. C.	E. Stroudsburg, Pa.	0	1
S. T. C.	Indiana, Pa.	0	0
R. I. Coll. Educ.	Providence, R. I.	0	0
S. Agr. & Mech.	Orangeburg, S. C.	0	0
N. S.	Spearfish, S. D.*	0	1
North. N. & Ind. S.	Aberdeen, S. D.	1	1
Middle T. T. C.	Murfreesboro, Tenn.	0	0
Sam Houston T. C.	Huntsville, Texas*	0	0
N. Texas T. C.	Denton, Texas*	0	3
S. T. C.	Farmville, Va.*	0	1
(No separate)	State of Utah	–	–
S. N. Train'g	Castleton, Vt.	0	0
S. N.	Bellingham, Wash.	0	1
S. N.	Fairmont, W. Va.*	0	2
Marshall Coll.	Huntington, W. Va.	1	1
Mil. S. T. C.	Milwaukee, Wis.*	1	0
Stout Inst.	Menomonie, Wis.*	0	2
(No separate)	State of Wyoming	–	–
Total		14	53

* Class *A*, Rating by the American Association of Teachers' Colleges.

S AND THEIR GREES		NUMBER OF COURSES OFFERED			ORGANIZATION OF WORK		
t degree .M.	A.B.	Semester	Quarter	Research	Separate Dept.	Part of science dept.	Combined with physics
1	0		3	0		√	
1	0		3	0		√	
0	0		7	0		√	
1	0		14	0			√
1	0	4		0			√
1	1	19		0			√
1	0	11		0	√		
2	0	8		0		√	
2	0	9		0		√	
1	0	7		0			√
0	0		29	0	√		
0	0		16	1	√		
0	0	0	0	0	no	no	no
–	–	–	–	–	—	—	—
–	–	–	–	–	—	—	—
1	0		6	0		√	
0	1		2	0		√	
1	0		10	0	√		
3	1		11	0	√		
2	0		15	0		√	
1	0		13	0		√	
2	0		19	0			√
1	0	9		0	√		
0	1	3		0		√	
1	0	12		0	√		
1	1		8	0	√		
0	1		2	0		√	
0	0	0	0	0	no	no	no
0	1	6		0		√	
0	0	0	0	0	no	no	no
1	1		31	0	√		
2	0		13	0			√
1	2		20	0			√
2	1		17	0	√		
0	0	0	0	0	no	no	no
0	0	0	0	0	no	no	no
1	1		15	0		√	
0	1		9	0			√
1	1	6		0		√	
1	0		10	0		√	
0	1		3	0		√	
1	0	6		0			√
0	1		10	0			√
–	–	–	—	–	—	—	—
0	0	0	0	0	no	no	no
0	1	5		0		√	
0	1		15	0	√		
2	2	16		0	√		
2	0	3	0	0		√	
0	0	0	0	0	no	no	no
0	1		3	0		√	
0	1		9	0			√
0	0	6		0			√
1	0	21		0	√		
1	0	21		0	√		
0	0	0	0	0	no	no	no
1	1	3		0		√	
0	1	6		0		√	
0	0	0	0	0	no	no	no
0	2	14	0	0	√		
1	0	7		0	√		
1	0		13	0		√	
0	1		11	0			√
0	2		12	0	√		
3	1		20	0	√		
:	0		16	0			√
:	–	–	—	–	—	—	—
0	0	0	0	0	no	no	no
:	0		3	0		√	
:	0	9		0	√		
0	0	17		0	√		
0	0	5		0	√		
:	1	6		0	√		
:	–	–	—	–	—	—	—
:	31	239	38	1	22	23	14

hoeffer, Kaiser Wilhelm Institute of Physical Chemistry, Berlin; and Dr. Francis Perrin, Physical Chemistry Institute, Paris.

Through the efforts of Dr. H. H. Barber, Local Secretary of the Minneapolis meeting, letters had been sent to 355 high-school and college teachers in the Minneapolis area inviting them to the luncheon and describing the activities of the American Chemical Society.

Chemistry classes had been invited to send exhibits, but the vacation period imposed a serious handicap. However, the following commercial firms exhibited their products in one of the large laboratories of the Chemistry Building:

Wm. Ainsworth and Sons, Inc. (precision balances); J. T. Baker Chemical Company (chemicals); Central Scientific Company (scientific apparatus); The Chemical Catalog Company, Inc. (scientific and technical books); Federal Phosphorus Company (chemicals); General Chemical Company (chemicals); Kewaunee Manufacturing Company (laboratory furniture); McGraw-Hill Book Co., Inc. (scientific books); Mallinckrodt Chemical Works (chemicals); Hoke, Incorporated (compressed gases; control valves; oxygen torches); Spencer Lens Company (optical instruments); Sterling Products Company (chemicals); W. M. Welch Scientific Company (scientific apparatus); Wilkins-Anderson Company (scientific apparatus).

The editors of the JOURNAL OF CHEMICAL EDUCATION met at dinner on the evening of September tenth. Neil E. Gordon, *Editor-in-Chief*, and Wm. W. Buffum, *Business Manager*, outlined the policies of the JOURNAL and the whole group discussed the problems which they presented.

Present: G. A. Abbott, R. A. Baker, A. P. Black, F. E. Brown, S. F. Buehrer, Wm. W. Buffum, Neil E. Gordon, G. B. Heisig, B. C. Hendricks, Wm. McPherson, H. W. Moseley, A. M. Pardee, W. F. Rudd, Wilhelm Segerblom, O. F. Stafford, J. N. Swan.

Minutes of the Meetings of the Executive Committee
8.00 A.M., Monday, Sept. 9th

Present: Wm. McPherson, *chairman*, R. A. Baker, *secretary*, Rosalie M. Parr, *treasurer*, Neil E. Gordon, Wm. Segerblom, and by invitation, Wm. W. Buffum, *business manager*, JOURNAL OF CHEMICAL EDUCATION, and H. H. Barber, *local secretary*.

(1) The report of the *Committee on Revision* was presented by Wm. Segerblom, together with mimeographed copies of (*a*) the revised constitution and (*b*) the committee's recommendations regarding the Senate. The report was accepted and discussed.

(2) The revised constitution was reviewed and was approved for presentation to the Division at its business meeting.

(3) The committee's recommendations that the Senate be empowered to elect its own chairman, and that the chairman be elected for a term of

three years and be eligible for reëlection for only one extra term for three years should such reëlection seem advisable, in order to assure the continuity of activity and facilitate the completion of the work of such committees as cannot finish that work in one year, were not adopted.

Voted that the chairman of the Division serve as chairman of the Senate.

Voted that the secretary of the Division serve as secretary of the Senate in order to keep the work of the Senate and of the Division properly linked.

(4) Voted that when the Senate shall have decided what problems in chemical education in their estimation should receive early attention, the chairman of the Division shall appoint the necessary committees to carry on the investigations, availing himself of any suggestions as to the personnel of such committees as the Senate may make. Such committees shall be considered committees of the Division and shall be listed in the JOURNAL OF CHEMICAL EDUCATION with the other standing committees of the Division.

(5) It was the sense of the meeting that it is inexpedient at this time to appoint a *Committee on Nomenclature.*

(6) The question of revising the names of the committees of the Division was referred to the *Committee on Naming and Scope of Committees.*

(7) The question of constituting a *Committee on Chemical Education by Radio* was referred to the *Committee on Naming and Scope of Committees.*

5.00 P.M., Monday, September 9th

Present: Wm. McPherson, *chairman*, R. A. Baker, *secretary*, Neil E. Gordon, Rosalie M. Parr, W. Segerblom.

(1) Neil E. Gordon, *chairman, A. C. S. Committee on Chemical Education*, reported that this committee had recommended to the President of the Society that this Committee be discharged since the Division is now prepared to take over its projects.

(2) Voted to dispose of the unfinished business of the *Committee on Chemical Education* as follows:

(*a*) The work of organizing associations of chemistry teachers and that connected with the Research Institute of Chemical Education was referred to the Executive Committee of the Division.

(*b*) The problem of correlating high-school and college chemistry was referred to a committee to be appointed by the chairman.

(3) The Secretary was instructed to furnish letterhead stationery to those committees needing it.

Minutes of the Business Meeting of the Division of Chemical Education 11.00 A.M., Monday, September 9th

Present: Wm. McPherson, *chairman*, R. A. Baker, *secretary*, C. T. Brown, Neil E. Gordon, Harrison Hale, C. R. Hoover, J. H. Jensen, Rosalie M. Parr, W. Segerblom, O. L. Shinn, and (by invitation) Wm. W. Buffum.

(1) The revised constitution was adopted and the Secretary instructed to present it to the Secretary of the American Chemical Society for ratification by the Council.

(2) Mr. Wm. W. Buffum, *business manager* of the JOURNAL OF CHEMICAL EDUCATION, outlined a proposal to publish the *Chemistry Leaflet*, the editor of which had sought aid from the Chemical Foundation and from the editor of the JOURNAL.

(3) A committee consisting of Neil E. Gordon, *chairman*, C. R. Hoover, and J. H. Jensen was appointed to consult with Mr. Wm. W. Buffum, and to report at the final business meeting of the Division on the advisability of the JOURNAL's taking over the publication of the *Chemistry Leaflet*.

(4) Rosalie M. Parr was appointed chairman of a *Committee on Resolutions* to report at the final business meeting.

(5) The chairman appointed the following members of the *Nominating Committee:* W. Segerblom, *chairman*, O. L. Shinn, and Harrison Hale.

(6) The chairman appointed the following members of the *Auditing Committee:* W. G. Bowers and J. H. Jensen.

Minutes of the Meeting of the Senate of Chemical Education Wednesday, 8.00 A.M., September 11th

Present: Wm. McPherson, *chairman*, R. A. Baker, *secretary*, G. A. Abbott, Friend E. Clark, Neil E. Gordon, Harrison Hale, B. Clifford Hendricks, J. H. Jensen, H. W. Moseley, Rosalie M. Parr, Wilhelm Segerblom, Oliver L. Shinn, J. N. Swan.

(1) The Secretary reported informally upon the deliberations of the *Executive Committee* and of the Division.

(2) *Women's Club Study Courses:* Harrison Hale, *chairman*, reported that, with the aid and coöperation of Mr. Francis P. Garvan and the Chemical Foundation, a course in American Chemistry is ready to be offered. The entire outline of this course will be published in the JOURNAL OF CHEMICAL EDUCATION, and later in pamphlet form for use in club study. Additional members of the committee are to be appointed, and the coöperation of all members of the Society is desired in bringing the matter to the attention of women's clubs. Report accepted and committee continued.

(3) *Naming and Scope of Committees:* Wilhelm Segerblom, *chairman*, reported that although opinions varied considerably within the committee on the value of prepared books of labels, the committee was unanimous

in feeling that a special *Committee on Labels* should be appointed to investigate the subject fully. A list of eight suggestive lines of investigation has been drawn up for the guidance of the special committee. On account of the absence of one of the committee in Europe, it was not possible to report to the Chairman of the Division of Chemical Education until early in June at which time the Committee submitted a list of suggestive lines of investigation and nominations of members for such committees. The Committee also reported progress on the matter of a *Committee on Library Equipment.* The report was accepted and the committee continued.

(4) *Minimum Equipment for Teaching High-School Chemistry:* J. H. Jensen, *chairman,* reported that a tentative list of equipment for the use of the individual pupil was submitted to the Senate of Chemical Education on April 16, 1928. The list with full report of the committee will be found in THIS JOURNAL, **5,** 749–54 (June, 1928). This tentative list has been revised and will soon be submitted to members of the Senate for such corrections as each member may deem advisable. Each member is requested to keep in mind that we are attempting to compile a list for the inexperienced teacher in the small high schools. Funds available for equipment are rather limited and an attempt has been made to secure the items that are absolutely necessary for individual work.

The second project of the committee is the preparation of a list of chemicals necessary. A study is being made of the grade and quantity of chemicals necessary and an attempt is being made to find out how many students a given quantity of a particular chemical may reasonably be expected to serve. Some ten of the commonly used manuals have been checked to date in order to secure the desired information.

(5) *Professional Spirit among High-School Teachers:* L. W. Mattern, *chairman,* reported by letter that his committee intends to investigate the preparation of chemistry teachers in high schools and other secondary schools, since this factor undoubtedly has a great influence on professional spirit. The report was accepted and the committee continued. The Secretary was instructed to request Dr. Mattern to coöperate with the committee on "Preparation of High-School Chemistry Teachers."

(6) *Major Topic Organization of High-School Chemistry:* Harry A. Carpenter, *chairman,* reported by letter that the work of organizing chemistry on the basis of major and minor concepts to be developed through the investigation of certain problems by pupils have now been tentatively completed by the local Rochester committee.

The findings of this local committee consisting of approximately eighty pages has been sent recently to members of the larger committee with the request that they make such study of the proposal as they are able and recommend what additional steps in their judgment shall now be taken

by the committee to further the investigation. The report was accepted and the committee continued.

(7) *Aids to Visual Instruction in Chemistry:* M. V. McGill, *chairman*, presented a progress report by letter. The committee has secured a list of sources of moving picture films and has been promised coöperation by the owners. The results of this preliminary survey will be published shortly in the JOURNAL OF CHEMICAL EDUCATION.

(8) *Order of Presentation of Recitation and Laboratory Work:* In the absence of the chairman, Rosalie M. Parr presented a progress report, calling attention to the completion of a study by the Illinois Association of Chemistry Teachers. The complete report will appear in the JOURNAL OF CHEMICAL EDUCATION. The report was accepted and the committee continued.

(9) It was voted to discontinue the *Committee on Research on Problems of High-School Chemistry Instruction*, and to refer such questions as may arise to the *Committee on Naming and Scope of Committees*.

(10) The Secretary was instructed to send greetings to Professor C. M. Chapin, *chairman, Committee on Research Problems*, expressing the regrets of the Senate at his absence, and its appreciation of the faithful service he has long rendered the Division and its best wishes for his speedy and complete recovery.

(11) The Secretary was instructed to express to Mr. Garvan and Mr. Buffum, of the Chemical Foundation, the Division's appreciation of their continued support and encouragement.

Minutes of the Business Meeting of the Division of Chemical Education 11.00 A.M., Thursday, September 12th

Present: Wm. McPherson, *chairman*, R. A. Baker, *secretary*, Dr. Mary Aloysius, George Bacharach, Paul W. Boutwell, W. G. Bowers, D. C. Farley, J. W. Geiger, Harrison Hale, Sister Marie Hilger, J. H. Jensen, J. A. Krance, Mary M. McCalmont, Sister Mary Rose Murray, Rosalie M. Parr, Earl W. Phelan, L. C. Railford, Hazel G. Robinson, Wilhelm Segerblom, O. L. Shinn, O. F. Stafford, J. N. Swan, J. W. Watson, J. A. Wilkinson.

(1) The minutes of the meetings of the *Executive Committee*, and of the Division on September 9th were read and approved.

(2) The Secretary reported briefly upon the adoption of the revised constitution, and the plan to solicit members for the Division.

(3) The treasurer presented a report, showing a balance of $27.35 in the treasury to date. This report will be incorporated in the final report for the calendar year.

(4) *The Special Committee on Chemistry Leaflet* recommended that the *Chemistry Leaflet*, which is now edited by Mrs. Pauline Beery Mack, be taken over by the Division of Chemical Education and published as a

weekly supplement to the JOURNAL OF CHEMICAL EDUCATION, and that Mrs. Mack be invited to continue her services in the editorial work of said *Leaflet*. The report was accepted and the committee discharged.

(5) *The Resolutions Committee* reported as follows:

(*a*) *Whereas*, through the very able management and clear foresight of our hosts, a most successful meeting of the Division of Chemical Education in Minneapolis was made possible, therefore, be it resolved that we extend to Professor S. C. Lind and his co-workers of the Minnesota Section, our thanks and our keen appreciation for their hospitality during the seventy-eighth meeting of the American Chemical Society.

(*b*) *Whereas*, by the request of the members of the *Committee on Chemical Education* of the American Chemical Society the activities and responsibilities of this committee have been transferred to the Division of Chemical Education, therefore be it resolved: (1) that the sincere thanks and appreciation of the Division be extended to this Committee for the constructive work done in the organization and establishment of the Division; (2) that the Division express its recognition of the tremendous work accomplished in specific educational lines by the Committee; such as the organization of chemistry teachers throughout the country, and the correlation of high-school and college chemistry; (3) that the Division most earnestly request the continued interest of the members of the Committee in the progress of the activities transferred to the Division. The report was accepted and the Committee discharged.

(6) *The Committee on Revision of the Constitution* was discharged.

(7) *The Nominating Committee* presented the names of J. N. Swan for *chairman*, and M. V. McGill for *vice-chairman*.

(8) It was voted to close the nominations and the secretary was instructed to cast a unanimous ballot for these two persons. They were then declared elected.

R. A. BAKER, *Secretary*

Manuscripts of Albrecht von Haller. According to the *London Times* of Jan. 31st, Signor Mussolini has presented to Switzerland a part of the scientific manuscripts of Albrecht von Haller, which were deposited at the Brera Library in Milan and in the University of Pavia. Haller has sometimes been called the father of modern physiology. Born at Berne on Oct. 16, 1708, as a boy he acquired knowledge with ease, and as a man displayed immense industry and unusual versatility. His medical studies were prosecuted at Tübingen and at Leyden, where he came under the influence of Boerhaave. He practiced for a time in his native town, and from 1736 until 1753 was professor of anatomy and botany at Göttingen. Returning to Berne, he there compiled his "Elementa Physiologiae" and other works, took part in public affairs, and corresponded with eminent men in all parts of the world. He died at Berne on Dec. 12, 1777.—*Nature* (London), **123**, 220 (Feb. 9, 1929).

THE CONSTITUTION OF THE DIVISION OF CHEMICAL EDUCATION OF THE AMERICAN CHEMICAL SOCIETY

Ratified by the American Chemical Society Council at Its Minneapolis Meeting, September 9, 1929

ARTICLE I.—NAME AND OBJECT

Section 1.—This Division shall be known as the Division of Chemical Education of the American Chemical Society.

Section 2.—The object of this organization shall be to offer a common meeting ground for those interested in different branches of Chemical Education, and to coöperate with other divisions and organizations, particularly with state or regional associations of chemistry teachers.

ARTICLE II.—MEMBERSHIP

Section 1.—There shall be two classes of members: active and associate.

Section 2.—Active membership shall be open only to members of the American Chemical Society.

Section 3.—Associate membership shall be open to any person who is interested in the objects of the Division and who is not a member of the American Chemical Society.

Section 4.—Associate members shall be entitled to attend the meetings of the Division and take part in the discussion of the papers, but shall not have the power of voting for officers, of holding office, or of giving papers before the Division. Associate members shall not be entitled to any other privileges of the American Chemical Society. Associate members may become active members of the Division upon joining the American Chemical Society.

Section 5.—There shall be no regular dues for active members but each active member will be expected to contribute $1.00 at the time of enrolment toward defraying the running expenses of the Division. Additional contributions may be called for as needed. Associate members must pay annual dues of at least $2.00.

Section 6.—Any person may become a member of the Division by filling out, signing, and sending to the Secretary of the Division a request essentially the same as that given below and shall remain a member as long as he fulfils the obligations imposed by the Division upon its members. An affirmative answer from the Secretary shall confirm the membership.

Form of Application for Membership

I (give name and address in full) hereby request the Secretary of the Division of Chemical Education of the American Chemical Society to enter my name as a member (mention whether active or associate is desired) of the Division and I hereby agree to observe the rules and by-laws of the Division as long as I am a member.

ARTICLE III.—OFFICERS

Section 1.—The Officers of the Division shall be a Chairman, a Vice Chairman, a Secretary, a Treasurer, an Executive Committee, and the Editor-in-Chief of the JOURNAL OF CHEMICAL EDUCATION.

Section 2.—The Executive Committee shall consist of the Chairman, Vice Chairman, Secretary, Treasurer, the three immediate past Chairmen of the Division, and the Editor-in-Chief.

Section 3.—At the first session of the Division during the annual meeting of the American Chemical Society, the Chairman shall appoint from the members present at the meeting, a committee of three to nominate officers, except the Editor-in-Chief, for the ensuing year. At the last business meeting of the Division this committee shall present its list of nominations.

Section 4.—All officers, except the Editor-in-Chief, shall be elected by ballot of the active members present at the last session of the Division during the annual meeting of the American Chemical Society, and shall take office at the close of the meeting at which they were elected. They shall hold office for one year or until their successors are elected, except the Secretary and Treasurer, who, if reëlected, hold office for three years.

Section 5.—The contributing editors shall be nominated by their respective Local Sections of the American Chemical Society, or by their respective State or Regional Associations of Chemistry Teachers, provided such associations have been approved by the Executive Committee of the Division. When the nominations of the contributing editors are approved by the Executive Committee they shall be considered duly elected. Where a State or Regional Association does not exist or has not been approved, the Executive Committee shall have power to appoint a contributing editor for the said section. The contributing editors shall be elected for three years, and such adjustments made at the beginning that the terms of one-third of the number shall expire each year.

The Editor-in-Chief shall be nominated by the contributing editors. The Secretary of the Division shall receive nominations by letter ballot. The term shall be for one year unless reëlected, when the said term of office shall be for three years.

The number of departmental editors shall be left to the discretion of the Executive Committee. They shall be nominated by the Editor-in-Chief, and their term of office shall expire with the term of the Editor-in-Chief.

When the nominations of the Editor-in-Chief and departmental editors have been approved by the Division of Chemical Education, they shall be considered duly elected.

Section 6.—Vacancies which may occur between meetings shall be filled by the Executive Committee.

Section 7.—It shall be the duty of the Chairman to represent the Division in the Council of the American Chemical Society, to preside at the meetings of the Division and of its Executive Committee and to execute their decisions and recommendations.

Section 8.—In the absence of the Chairman, his duties, except that of representing the Division in the Council, shall be performed by the Vice Chairman.

Section 9.—It shall be the duty of the Secretary to arrange the program for the meetings, to record and preserve the minutes and proceedings of the Division and of the Executive Committee, to keep a list of the active and associate members, to send members such notices as may be required, to transmit to the Secretary of the American Chemical Society the names of all officers and committees of the Division within three weeks of their election or appointment and to notify the secretary of the American Chemical Society of any changes in officers and committees during the year.

Section 10.—It shall be the duty of the Treasurer to receive all contributions and collect all dues from members, to have charge of the funds of the Division, and to make such disbursements therefrom as may be authorized by the Executive Committee.

Section 11.—The Executive Committee shall manage the affairs of the Division and any other work delegated by the Division. The Executive Committee shall authorize the disbursement of funds to be made by the Treasurer.

ARTICLE IV.—MEETINGS

Section 1.—There shall be a meeting of the Division at each general meeting of the American Chemical Society. The reading of papers and discussions shall constitute the major part of the program.

Section 2.—The business meetings of the Division shall come at such times as the Chairman and Secretary shall select and the order of business shall be substantially as follows:

Reading of Minutes
Report of Secretary
Report of Treasurer
Report of Executive Committee
Report of special committees and discussion
Miscellaneous business.

ARTICLE V.—AMENDMENTS

Section 1.—Amendments to this Constitution shall be made only at the annual meeting of the Division by a two-thirds majority of the active members present, provided a two months' notice in writing of the

proposed amendment has been sent to the active members of the Division.

Section 2.—The amendments to the Constitution to be effective must be approved by the Council of the American Chemical Society.

By-Laws

ARTICLE I.—COMMITTEES

The Chairman shall appoint such standing or special committees as may be necessary to consider, transact, and report upon special matters of business, provided, however, that such appointment shall not hold over after the term of the chairman has expired.

ARTICLE II.—PUBLICATIONS

The official organs of the Division shall be the *Journal of the American Chemical Society*, *Industrial and Engineering Chemistry*, and the JOURNAL OF CHEMICAL EDUCATION. Authors who intend to publish the papers which are read before the Division must submit their contributions to the editor of one of the society's journals or to the editor of the JOURNAL OF CHEMICAL EDUCATION, before they can be published elsewhere; and if published in any other periodical, the statement that the paper was read before the Division at a specified meeting of the American Chemical Society must be made.

ARTICLE III.—AMENDMENTS

These by-laws may be amended by a two-thirds majority of the active members present provided a two months' notice in writing of the proposed amendment has been sent to the active members of the Division.

Austrian Memorial to Humphry Davy. A memorial tablet to Sir Humphry Davy has just been unveiled in the Pump Room of the Wirer Endowment at Ischl in Austria, to commemorate his stay at that watering-place. The ceremony was performed in the presence of a distinguished party, including the Austrian Chancellor, Dr. Streeruwitz, who in a speech dwelt upon the gratitude the world owes to the inventor of the miner's safety lamp. It was on May 26, 1818, that Davy embarked at Dover for Naples, whither he was going to study the problem of unrolling the papyri found at Herculaneum. His journey took him up the Rhine and Danube into Austria and Hungary, and on this journey he took the opportunity of making observations of the formation of mists over rivers and lakes, which at that time was not understood. The rivers he studied included the Inn, the Ilz, the Raab, the Save, the Ironzo, the Po, and the Tiber, his results being contained in his paper to the Royal Society of Feb. 25, 1819, entitled "Some Observations on the Formation of Mists in Particular Situations."—*Nature*, **124**, 155 (July 27, 1929).

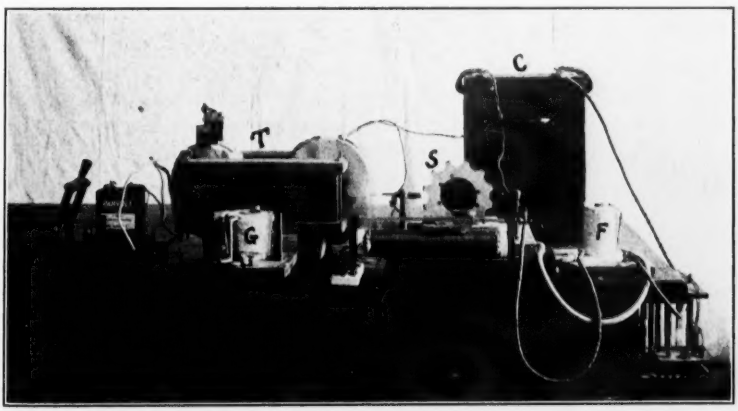
The Chemistry Student

SOME FAILURES AND SUCCESSES WITH HIGH FREQUENCY FURNACES

JOHN KISSEL AND WILLIAM HAMM, MARYHURST NORMAL, KIRKWOOD, MISSOURI

In the November, 1928, issue of THIS JOURNAL (pp. 1491–2) there appeared an article describing the construction of a small arc furnace. At the end of the article, reference was made to an induction furnace which the author threatened to tell about "if dreams came true." Well, they have come true, and this article bears out the threat.

We read what literature we could find on the subject of high frequency furnaces, and that was very little. However, we were impressed with the



THE HIGH FREQUENCY OUTFIT ASSEMBLED

T, transformer; *C*, condenser; *S*, spark gap; *F*, furnace; *G*, another furnace not connected.

speed with which these furnaces work, and the ease and exactitude with which the conditions of an experiment can be reproduced. We therefore concluded that such a furnace would certainly be a very desirable piece of laboratory apparatus, and then set about to construct one.

We first constructed a high frequency apparatus of one-half kilowatt capacity. This was designed primarily for a Tesla coil, but we hoped that it would operate a furnace also. The primary coil of the transformer con-

sisted of about 325 turns of No. 14 wire and the secondary of 16,500 turns of No. 30 wire. These coils were wound by hand on an improvised winder, and the operation consumed all our free time during several weeks. The condenser was made of 120 5″ × 7″ negatives from which the emulsion had been removed. Sheets of tinfoil were placed between the plates and properly connected. The assembled condenser was then immersed in an insulating mixture of melted beeswax and rosin. The spark gap was of the stationary kind formerly used in wireless sets.

The first furnace was a very rudimentary affair. It consisted merely of a helix of heavy copper wire wound around a glass tumbler. We put a crucible full of type metal into the tumbler, made the connections, and turned on the current. In a few minutes the type metal became hot, and soon a part of it melted. That was encouraging.

We now set about making what we considered to be a real furnace. We

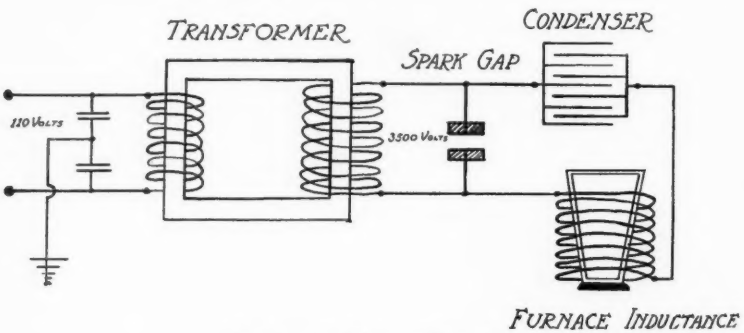


DIAGRAM OF FURNACE HOOK-UP

wound a twenty-five foot length of $^3/_{16}$-inch copper tubing into a helix about four inches in diameter; then, by a laborious and unpatented method, flattened the tubing so as to increase the number of turns per inch without, however, damaging the tubing to such an extent that it could not again be used to transmit a flow of water. When completed, the helix measured a little more than four inches in height and had about twenty-eight turns. Retort cement was used to insulate the turns from each other, and a liberal coating on the inside of the coil made it quite rigid. A clay crucible was then placed inside the coil and magnesite packed tightly around it.

We placed an ingot of aluminum in the crucible and turned on the current. Now, we had agreed that the aluminum must be melted before the furnace could be called a success. After a ten-minute run we uncovered the crucible, only to find the aluminum about as cold as when we had put it in. Several subsequent runs, made after all the connections, etc., had been gone over, gave the same result. Evidently, our furnace was a failure.

We made another by cutting rings out of sheet copper, cutting them open, and soldering a number of them together to form a helix. This gave a great number of turns per inch, but the coils got hotter than the contents of the crucible. Then our big furnace was dismantled and reduced in size to about $2^1/_2$ inches in diameter, but without satisfactory result. We succeeded in melting zinc, but zinc is not aluminum. We were forced to conclude that our generator was not sufficiently powerful. So it was up to us to construct a more powerful generator, or quit.

Now, quitting is not our long suit. We disposed of the $^1/_2$-kilowatt outfit and procured the material for a 5-kilowatt transformer. Profiting by previous experience, we soon had the coils wound and the transformer assembled. This time the primary had only 100 turns of No. 7 wire and the secondary about 3600 of No. 24. The condenser was constructed along the same lines as the one previously used, but it was much larger. We used $8'' \times 10''$ plates and immersed the condenser in oil instead of the messy beeswax-rosin mixture. We also fabricated a rotary spark gap from material available in the physical laboratory.

The furnace was once more dismantled and remodeled, its diameter being reduced to a little more than two inches. A very serviceable crucible was made by boring a $^5/_8$-inch hole in a battery carbon to a depth of about three inches. This crucible was again insulated from the coil with magnesite. All parts being properly assembled and connected, we were ready for the test.

We began gently by filling the crucible with type metal. It melted in ten seconds. That was more than encouraging, and we immediately put into the crucible our famous ingot of aluminum. In one minute it had turned into a liquid. That meant success according to our definition, but we had become ambitious and kept right on. Brass melted in five minutes, copper in eight, and iron in a little more than twelve. Now we are ready to pronounce our furnace a success according to any definition.

These experiments consumed the greater part of our spare time for nearly a year, yet we enjoyed the work immensely and found it extremely interesting. And now, to be sure, we know considerably more about high frequency furnaces than we did when we began.

It is indisputably evident that a great part of every man's life must be employed in collecting materials for the exercise of genius. Invention, strictly speaking, is little more than a new combination of those images which have been previously gathered and deposited in the memory: nothing can come of nothing: he who has laid up no materials can produce no combinations. The more extensive, therefore, your acquaintance is with the works of those who have excelled, the more extensive will be your powers of invention, and, what may appear still more like a paradox, the more original will be your conceptions.—SIR JOSHUA REYNOLDS

CHEMISTRY FOR THE AMATEUR PHOTOGRAPHER. I. THE CHEMISTRY OF PHOTOGRAPHIC MATERIALS*

The art of photography is founded upon the fact that the compounds of silver, and especially its compounds with chlorine, bromine, and iodine, are sensitive to light.

The earliest photographs were made by coating paper with silver chloride and using this to form images by its darkening under the action of light, but the sensitiveness of the silver chloride was too slight to use it in this way to form images in the camera.

To get results which require less exposure to light, advantage is taken of the fact that it is not necessary for the light to do the whole work of forming the image; it is possible to expose the silver salt for only a short time to the light and then to continue the production of the image by chemical action, the process being termed "development."

Sensitive photographic materials therefore consist of paper, film, or glass, coated with a layer in which is suspended the sensitive silver bromide or silver chloride. This layer is called the *emulsion*. The emulsion consists of a suspension of the silver salt in a solution of gelatin. If there were no gelatin in the solution the silver compound would settle to the bottom and an emulsion would not be formed, but the gelatin prevents the settling so that the precipitated silver salt is uniformly distributed through the solution.

Photographic materials which are to be developed must contain no excess of soluble silver and the emulsion must be made so that there is always an excess of bromide or chloride, since any excess of soluble silver will produce a heavy fog over the whole of the surface as soon as the material is placed in the developer. In the case of Solio paper, however, which is not used for development but which is printed out, a chloride emulsion is made with an excess of silver nitrate. This causes rapid darkening in the light so that prints made upon Solio paper are not developed, the visible image being toned and fixed. Solio paper can be developed with certain precautions, such as by the use of acid developers or after treatment with bromide to remove the excess of silver nitrate.

In the early days of photography prints were usually made on printing-out papers, but at the present time most prints are made by the use of developing-out chloride and bromide papers, which are chemically of the same nature as the negative-making materials and are coated with emulsions containing no free silver nitrate.

* This series of articles is based upon selected chapters from "Elementary Photographic Chemistry" and "The Fundamentals of Photography," by Dr. C. E. K. Mees, published by the Eastman Kodak Company, Rochester, New York. Cuts also are by courtesy of the Eastman Kodak Co.

Negative-making materials such as plates and films always contain silver bromide with a small addition of silver iodide. The different degrees of sensitiveness are obtained by varying the temperature and the duration of heating which the emulsions undergo during manufacture, the most sensitive emulsions being heated to higher temperatures and for a longer time than the slower emulsions.

If a slow bromide emulsion is coated upon paper, the material is known as *bromide paper* and is used for printing, and especially for making enlargements. The less sensitive papers which are commonly used for contact printing by artificial light contain silver chloride in the place of silver bromide.

In order to obtain silver nitrate the first step is to dissolve metallic silver in nitric acid. The silver replaces the hydrogen of the acid and forms

CRYSTALS OF SILVER NITRATE

silver nitrate, the hydrogen liberated decomposing a further portion of the nitric acid. The silver nitrate is crystallized out of the solution and obtained in colorless, transparent plates.

Silver nitrate for photographic use has to be extremely pure, and since metallic silver usually contains a small quantity of other metals, such as copper and lead, it is necessary to free it from these impurities. This is accomplished by recrystallization, so that the silver nitrate is finally obtained in a perfectly pure form.

Silver nitrate is very soluble in water. It attacks organic material, and blackens skin, wood, cloth, and other similar substances on exposure to light.

When a solution of silver nitrate is added to a solution of a bromide or chloride of another element, a reaction occurs and the insoluble silver brom-

ide or chloride is precipitated. Thus, if we add silver nitrate to potassium bromide, the reaction occurs according to the following equation:

$$AgNO_3 + KBr \longrightarrow AgBr + KNO_3$$

The potassium nitrate formed remains in solution, but if the solution is at all concentrated, the silver bromide is thrown down as a thick, curdy precipitate.

The bromides and chlorides used in photography are chiefly the salts of potassium and sodium. Both the bromides and the chlorides are obtained from naturally occurring salt deposits, but, whereas these deposits consist chiefly of chlorides, they contain only a very small quantity of bromide, and bromide is therefore a very much more expensive material than chloride.

The elements chlorine, bromine, and iodine are all obtained from natural salt or from the sea, iodine being derived from certain sea weeds which extract it from the sea water and thus make it available in a concentrated form. Chlorine is a yellowish green gas, very suffocating and poisonous, bromine gives dark red fumes which are even more noxious than chlorine and condense to a liquid, and iodine forms shining, black crystalline flakes which on heating give a violet vapor. The chief chlorides, bromides, and iodides used in photography are the following:

Ammonium Chloride: White crystals soluble in water. Made from ammonia and hydrochloric acid, should have no odor, and when evaporated by heat should leave no residue behind.

Ammonium Bromide: Very similar to the chloride, which is the only impurity likely to be present.

Ammonium Iodide: Should consist of colorless crystals. Decomposes in light and is stained yellow by the iodine liberated. Very soluble in water and deliquescent. Soluble in alcohol.

Sodium Chloride: Ordinary table salt is fairly pure sodium chloride and a very pure salt is easily obtained. The pure salt is stable and not deliquescent. Soluble in cold water (40°F.) (4°C.) to the extent of 31 ounces of salt to 100 fluid ounces of solution. Solubility increases very little on heating.

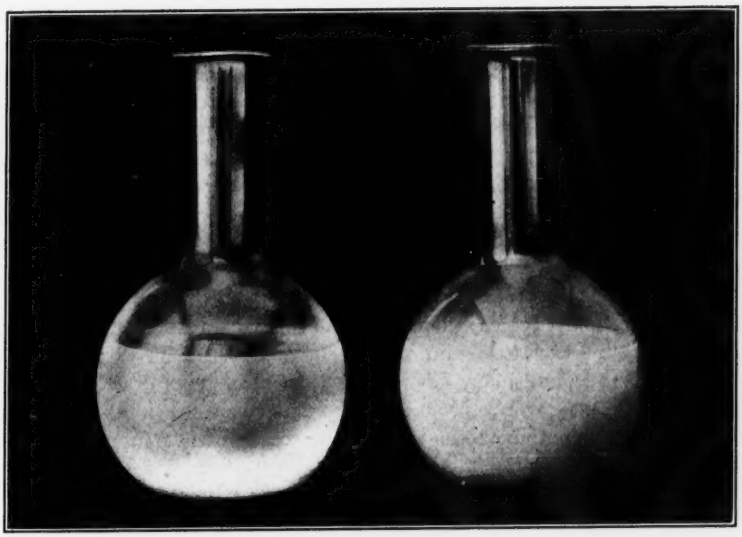
Sodium Bromide: A white salt, similar to the chloride but more soluble. Is generally pure but may contain chloride.

Potassium Chloride: White salt, very similar to sodium chloride.

Potassium Bromide: Occurs as colorless cubical crystals and is generally pure. To facilitate handling and weighing, potassium bromide is usually supplied in the granular form. Very soluble in water.

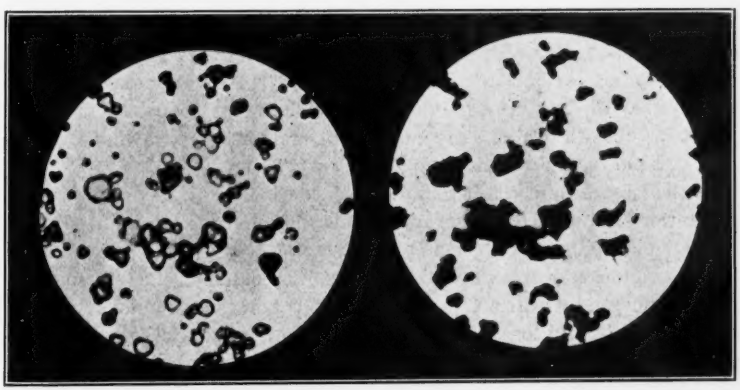
Potassium Iodide: Similar to bromide. Very soluble. May contain as impurities carbonate, sulfate, and iodate, but is usually pure. A solution of potassium iodide dissolves iodine, which is insoluble in water, and it is therefore used to prepare a solution of iodine.

The gelatin which is used to emulsify the sensitive silver salts is a very complex substance which is obtained from the bones and skins of animals.



TWO FLASKS CONTAINING PRECIPITATED SILVER BROMIDE

The flask on the left shows that silver bromide without gelatin settles to the bottom of the solution. The one on the right shows the silver bromide held evenly in suspension by gelatin.



CRYSTALS OF SILVER BROMIDE BEFORE (LEFT) AND AFTER (RIGHT) DEVELOPMENT

The photographs above, taken through a very powerful microscope, show crystals of silver bromide before development (on the left) and (on the right) some crystals after they have been changed into metallic silver by development. The crystals before development are transparent except where they are seen sideways or where their edges appear darker. After development the clear yellow silver bromide is turned into a black coke-like mass of silver in exactly the same position as the crystal from which it was formed.

Gelatin has some curious and valuable properties. In cold water it does not dissolve but it swells as if, instead of the gelatin dissolving in the water, the water dissolves in the gelatin. If the water is heated, the gelatin will dissolve, and it can be dissolved to any extent. It cannot be said that there is a definite solubility of gelatin in water in the same sense as salts may be considered to have a definite solubility. As more gelatin is added, the solution becomes thicker. If the gelatin solution is heated, it will become thinner and less viscous when hot, and will thicken again as it cools, but it will remain thinner than if it had not been heated so that the heating of the gelatin solution produces a permanent change in its properties. If a gelatin solution is cooled, the gelatin will not separate from the solution in a dry state but the whole solution will set to a jelly. If the jelly is heated again, it will melt, and a jelly can be melted and reset many times. During the treatment there will be produced a progressive change in the jelly, and if the process is continued long enough, the solution will refuse to set and will remain as a thick liquid.

In the preparation of a photographic emulsion the gelatin is soaked in water, and then when it is swollen it is dissolved by putting it in warm water and gently warming and shaking until it is all dissolved. Then there is added to this the right quantity of bromide. The bromide dissolves in the gelatin solution just as salt would, and is stirred up to get it evenly distributed. Meanwhile, some silver nitrate has been weighed out so that the right amount is taken to act with the amount of bromide chosen and is dissolved in water, in which it dissolves very easily. This silver nitrate solution is then added slowly to the bromide dissolved in the gelatin, and produces at once a precipitate of silver bromide. The silver bromide is sensitive to light so that before adding the silver nitrate to the bromide and gelatin all the white lights are turned out and the silver is added by the light of a photographic red lamp.

As the silver is added a little at a time, the solution being stirred meanwhile, the gelatin becomes full of the smoothly, evenly precipitated silver bromide distributed through the solution.

If the emulsion of silver bromide in gelatin is coated on the film and then cooled, the gelatin will set to a jelly, still containing the silver bromide suspended in it, and then when this layer is dried, we get the smooth yellowish coating, which is familiar to those of us who have looked at an undeveloped film in the light.

If we look at the silver bromide film through a very high power microscope, we shall find that the silver bromide is distributed throughout it in the form of tiny crystals. These crystals are in the form of flat triangular or hexagonal plates, and careful investigation has shown that they belong to the regular system of crystals. When these crystals are exposed to light, no visible change takes place, but there must be some change because

when a crystal of silver bromide, which has been exposed to light, is put into a developer, the developer takes the bromine away from the silver and leaves instead of the crystal what looks under a microscope like a tiny mass of coke, which is, really, the metallic silver itself freed from the presence of the bromine.

It may seem strange that silver, which we always think of as a bright, shiny metal should look black, but when it is divided up in this irregular way, it looks black, although it is the same thing as the shiny metal we are familiar with, just as a black lump of coke is the same thing as the bright gleaming diamond. If the silver bromide has not been exposed to light, then the developer has no power to take away the bromine from the silver.

Wherever, then, the light in the camera has acted upon the silver bromide crystals in the emulsion, the developer turns them into black grains of silver and we get an image, and where the light has not acted the developer has no action and no image is produced. The chemical part played by a developer, therefore, is the freeing of the metallic silver from the bromine associated with it.

Gelatin belongs to the class of substances which are called colloids, the name being derived from a Greek word meaning "gummy." When a gelatin jelly is dried it shrinks and forms a horny or glassy layer of the gelatin itself, smooth and rather brittle. This dry gelatin, when placed in water, will at once absorb the water and swell up again to form a jelly. This swelling and shrinking are of great importance in photography. When a photographic material with an emulsion made with gelatin is placed in water, the film will swell up and will continue to absorb more water and swell for a long time, finally becoming soft and even dissolving, the extent to which this occurs depending on the temperature and the nature of the solutions in which it is placed. A small quantity of either an acid or alkali will produce a considerable increase in the swelling, and since the developer is alkaline and the fixing bath is acid, both these solutions have a great tendency to swell the gelatin, especially when they are warm. In order to avoid difficulty from this source, gelatin emulsions have a hardener added before they are coated, gelatin being hardened and made more resistant to swelling by the addition of alum.

Under ordinary circumstances no difficulty is experienced by the photographer due to the softening of the gelatin, but when photographic materials are exposed to extreme temperatures, care must be taken in handling them. Hardening agents, such as alum, must be added to the fixing bath, and all solutions must be kept at the same temperature in order to avoid sudden contractions or expansions of the gelatin which may result in detaching the film from its support or in the production of reticulation, *i. e.*, a coarse wrinkling all over the film.

A CHEMISTRY CLUB'S CONTRIBUTION TO ITS UNIVERSITY

Every school and university organization likes to feel that it has made some permanent and tangible contribution to the institution of which it is a part. Every worthwhile organization does make intangible contributions which are doubtless far more valuable than any material gifts which it could bestow. Yet there is an additional satisfaction in being able to point to some concrete object of value which commemorates the club or class of which one has been a member.

The opportunities for chemistry clubs in this respect are numerous. Special pieces of apparatus which the institution cannot afford to buy or which, though desirable, would be used too little in regular course work to justify the expenditure, may sometimes be constructed at relatively small cost for materials. The writer has personal knowledge of one small group of students in a high-school physics class which built and presented to the institution a very creditable X-ray outfit. The physics department purchased the X-ray tube, but every other unit of the set was constructed by the students. Incidentally, this apparatus was applicable to other uses, such as Tesla coil experiments, etc.

Other groups have, over a period of years, made or accumulated valuable collections of wall charts, tables, diagrams, etc., and of lantern slides and other projection material. Still others have undertaken to care for and add to museum collections to be used for instruction and for general educational display. Further possibilities are represented by scrapbooks or files of magazine articles and pictures relating to chemicals and chemical processes which are studied in the chemistry course. Clubs may also contribute magazine subscriptions and popular books on chemistry to build up a library for themselves and future students.

Nor should we overlook the value of gifts which might properly be classed as esthetic rather than utilitarian in purpose. Good prints or photographs of famous chemists or other chemical subjects suitably glassed and framed are worthwhile adornments to any classroom or laboratory. Of this order also are the wide variety of decorative or memorial plaques which find appropriate place in the halls of science. (One such plaque—that presented to the new chemistry laboratory of the University of Ohio by the first-year chemistry classes of 1926–27—was described and pictured in the February, **1929,** JOURNAL, p. 332.)

The accompanying illustration shows the allegorical bas-relief presented to the chemistry laboratory of the University of Cincinnati by the student chemists' club. It was purchased for the club in Germany by Prof. R. E. Oesper who has kindly furnished us with the photograph here reproduced. The panel is a galvano-plastic of light metal, probably silver-plated, and mounted in a dark wooden frame.

ALLEGORICAL PLAQUE—"ART AND SCIENCE"—PRESENTED TO THE CHEMISTRY LABORATORY OF THE UNIVERSITY OF CINCINNATI BY THE STUDENT CHEMISTS' CLUB

The title is "Art and Science." Mankind, represented as an old man, seated on the Sphinx, "The Eternal Riddle," is peering over the Sea of Ignorance, whose waves vainly dash against the foundations of the Temple of Learning. The blindfold over his eyes is being removed by Science, while her assistant Art is noting the new revelations. A pyramid is faintly seen in the right background, typifying the endurance of scientific achievement.

Prof. Oesper has furnished us with information as to the cost of the plaque as well as with the name and address of the manufacturer. This information we will be glad to transmit to interested readers upon request.

Chemistry in 1876. The Editor has been given a bound copy of *Harper's Weekly*, including all issues of this periodical from July 1, 1876, until December 30, 1876. Reading through the columns published more than fifty years ago reveals many chemical news items. These are chronicled each week under the caption "Scientific Intelligence."

In the edition of July 1, 1876, we find Ira Remsen's contribution to the study of the constitution of phosphorous oxychloride.

July 15th, and we note the "Chemical Subsection formed at the Hartford Meeting has been made a permanent organization" of the American Society for the Advancement of Science.

July 22nd. "M. Lecoq de Boisbaudran has at last succeeded in isolating gallium in sufficient quantity for the determination of its chief physical properties."

"According to Deville and Debray, osmium is the heaviest substance known, having a specific gravity of 22.477."

July 29th. "Friedelite is a hydrated silicate of manganese, discovered by Bertrand."

"The health authorities of Paris have lately prohibited the sale in that city of Cincinnati hams, which, as is well known, are generally put up in canvas, colored of a brownish hue. According to the results of a chemical investigation, this color is due to chrome yellow, or the chromate of lead, which is in itself a highly poisonous substance."

September 2nd. "Dr. Jolly, in correction of a previous memoir on the phosphate of lime, remarks that of the two elements, phosphoric acid and lime, constituting the soluble and insoluble, the former is absorbed in a certain proportion at once; the second or the lime, is rejected almost entirely by the intestinal canal."

October 7th. "As the result of an examination of atmospheric dust, the mineral residuum from the melting of snow, etc., with special reference to iron in the atmosphere, Mr. Yung remarks that this metal, in appreciable quantity, occurs in the dust accumulated in old buildings and is usually of a globular form. The iron as found in melted snow is much more irregular in shape, and is more abundant in proportion when the snow is collected at the lower levels."

October 14th. "Messrs. Menetti and Musa find that salicylic acid is very serviceable in the preservation of milk."

December 30th. "A new class of bismuth compounds, discovered by Carnot, furnishes a delicate method of detecting potassium. These compounds are double hyposulfites of bismuth with the alkalies, and, unlike other bismuth salts, are completely soluble in water."—*The Catalyst*

THE ARABIAN BARBER SHOP*

WILLIAM L. LAMAR, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND

CHARACTERS

PASHUN MOHAMMED BEN ABAD: An Arabian
TONY: A Barber.

STAGE

The stage is set with all necessary equipment. On each side of the stage is a twenty-liter bottle filled with ammonia gas. These bottles are fitted with stoppers and pipet stems and inverted in containers of water. The water in one may contain some phenolphthalein while the other may contain some thymolphthalein. The red and blue fountains thus produced operate during the act.

The curtain rises. Business is dull. Tony is seated in the barber chair reading the supposedly current news, jokes, etc., from the school publication and he makes humorous comments on the news. Enter Pashun, dressed in traditional Arabian costume with turban afire[1] and carrying a "magic" cane.

Pashun: I am Pashun Mohammed Ben Abad, the great Caliph of the Garden of Allah. I am on fire with love—without me there can be no love—for I am love.

Tony: Yes, but you're at da University of —— now. Da girls they can no go out after 7.30.

Pashun: I am a magician, the greatest prophet since the Hegira. You are now beholding a Wizard. I can do what no other human man can do.

Tony: But you ina da wronga place—you're ina da University of —— Barber Shop. You getta da shave, haircut, getta da hair tonic, gin, whita mule, alcohol, whiskey, bacardi, Scotch.

Pashun: My name is spoken in many languages. In all of them it means mystery. Where I am, I am not. I fear nothing. My protector is the goddess of fire. By all the suns and stars I must have combustion. Bring me a jug of water so that I may strike this match.

Tony: (With mingled expression of fear and incomprehension.) You may be da bigga trickster of da seven seas, but you're dumba just the same. Strike it lika dis. (Strikes match on trousers.)

Pashun: In my land of the east we do not wear that kind of pants. Bring me a jug of that inert liquid called water. (Tony brings him beaker of concentrated H_2SO_4. Pashun lights especially prepared match by touching it to the acid. Lights cigarette with match, using cigarette holder.)

* This play should be presented only under experienced supervision.

[1] A solution of CCl_4 and CS_2 is used to produce this effect. See "Directions for Tricks Used" at end of this paper.

Tony: Of all da dumba ways to do t'ings, you picka da dumbest. Next t'ing you t'row water on da fire to starta it, maybe.

Pashun: Fire, which has been a mystery to the Eskimos, has been a light to Arabs. Bring me a jug of that colorless, odorless, tasteless, homogeneous liquid called water. (Tony appears somewhat dazed. Brings a beaker of water.) I must test this liquid. (Drinks—looks very satisfied—drinks more.) Ah! It is water. With this most excellent water I will start a fire. (Makes motion with cane. Pours water on sawdust mixed with Na_2O_2.)

Tony: Your country must be ona da bum. We usa da water in dis country to puta out da fire. You runa all da fire companies outa da business.

Pashun: (Paying no attention.) I fear neither the gun nor the sword. In my language there is no word that means fear. (Takes cloth, pours on it a mixture of CS_2 and CCl_4—pours some on his hands—lights cloth and also his hands, using prepared match touched to concentrated H_2SO_4.)

Tony: (Excited.) You setta on fire da barber shop. You burna down da place—I no gotta da insurance—I losa da haircut money.

Pashun: (Paying no attention.) I speak and it is done. I say let there be rain and there is rain. (Bucket of water, fixed above stage is dumped. It falls on some inconspicuous absorbing material.)

Tony: Who wanta rain in da barber shop. Da hair, she grow without rain. (Angrily.) Why you old sheik of the whiskered Nile—I meana you ——.

Pashun: (Paying no attention.) I say (waving cane) let the water disappear and there is no water.

Tony: (Rushes over and feels spot where water fell. Assumes mingled expression of surprise and fear.) Dry as a Turkish Bath! How you do it?

Pashun: (Big gong in clock on stage rings.) Ah! the clock striketh on the 18th minute mark. (Give whatever time the clock says, but the clock should not read any even hour or half hour.)

Tony: Even da clock she go bug house.

Pashun: (Takes bottles of supposed hair tonic from shelf, arranges them in order on table in plain view.) I will say the magic words and they will change color, each one changing in the order which I so desire. By Graham's Law of Diffusion the velocities of two gases are inversely proportional to the square roots of their densities. When my magic words diffuse through these solutions they will change in color. Tabataba, Ali, Fatima, Alimenzy Camel—Solution thou art blue—blue. Wabadata—thou art blue—blue. (Solution should turn blue—use carefully prepared timed solutions.)

Tabataba, Ali, Fatima, Alimenzy Camel—Solution thou art yellow—yellow. Wabadata—thou art yellow.

Tony: (In rage.) You bigga bum—you changa da aspects. Now da hair tonics alla ruined. You wrecka da barber shop. You getta in da damage suit. I winna da damage suit—you paya da money for da hair tonics. (While Tony is talking Pashun lights cigarette using a piece of paper recently dipped into a solution of phosphorus in CS_2.)

Pashun: (Disregarding Tony's diatribe.) My will power is great—my power prevaileth over all things. I can command the smoke from this cigarette to pass through my body and out of my hand. (Has tube of titanium tetrachloride in pocket and connection running down inside of coat sleeve to hand. Lets out a tremendous puff of smoke.)

Tony: Well I be damned!

Pashun: (Smoking cigarette, puts hands to head, then holds them out as if trying to receive a message.) I have a premonition—a message from Grasonna.

Tony: Some more girl friend?

Pashun: I have a feeling that my life is in danger. Ah! I have it! In 60 seconds this cigarette will explode with terrible violence. I will hold it in my mouth 58 seconds and then remove it. (Takes out watch—at end of time throws it into cuspidor which contains charge of flash powder. This is set off by backstage electrical connection.)

Tony: (Sarcastic.) A little more, da Garden of Allah losa da Pashun.

Pashun: It is growing dark. (Some of the lights go out.)

Tony: I guessa you predicta dat. You so smarta; maka da light again.

Pashun: (Waves cane—lights come on and then go off again.) This is a magic cane. It was presented to my great ancestor, El Khakan of the house of Mohammed, in the year of the Hegira 236. It is endowed with supernatural powers. With this cane I will light the candle on the table. (Table downstage has candles on it. Candles are especially prepared. When lights go dim Pashun puts phosphorus on end of cane or use gas pilot lights which look like candles. Lights candles.)

Tony: (Stage lights come on.) Who saida I want da candles light. You gotta too mucha light. You wasta da haircut money.

Pashun: (Paying no attention.) Pray tell me what kind of an abode is this, for never before in my life have I seen such a place.

Tony: Say, where you been—in a trance? You looka like you never see da barber shop. Dis is da barber shop.

Pashun: (Reflectively.) A barber shop. How strange. Pray tell me what can one do in a barber shop.

Tony: Oh, lotsa t'ings, reada da newspaper, tella da joke, see da funny people, smoka da cigar, getta da hair tonic, getta da haircut and shave.

Pashun: (Pleased.) When I return to my Garden of Allah I shall introduce there the barber shop. But tell me, what is a shave?

Tony: (Stropping big razor.) I show you. It remova da hair off da face.

Pashun: But how can I remove it?

Tony: Oh, nitric acid, sulfuric acid, hydrochloric acid—whicha you have?

Pashun: Nitric acid? Sulfuric acid? Hydrochloric acid? I will accept only the best; give me a mixture of all three. (Tony puts Pashun in barber chair and goes to sink. Chair is mounted on an axle so that it throws Pashun out backward on a mat.)

Tony: Da shave, she not started yet. You staya in chair. (Tony has to pull Pashun into barber chair; he goes over to sink again. Chair dumps Pashun again.) I see I gotta watcha you. You coma to da sink. I fix it you no jump offa da chair. I no puta you in da chair. (Pashun with his back turned to audience takes off whiskers. Tony lathers him. Introduces a mixture of hydrogen and oxygen into the lather with an atomizer. Tony takes Pashun to the barber chair. Strops razor. Begins shaving, when bubbles are set off with a cigarette. *(Caution!)*

Pashun: (Feeling face.) Ah! you are a wizard of the west. I shall make you my adviser—you shall be my second-hand man. My harems shall be at your disposal.

Tony: (Still looking frightened, goes over and feels Pashun's face.) Gone!

Pashun: Why certainly they're gone. You are the eighth wonder of the Nile. Oh, great wizard, what can I do for you?

Tony: (Recovering.) You scara alla da trade away—paint for me some signs to bringa da customers.

Pashun: Speak and it is done. (Brings out large billboard having on it a prepared blank sign. Pashun paints in yellow as follows: "This is a barber shop.")

Tony: Da people know dis is a barber shop. Painta da sign—say how good I cut da hair—how shorta—how longa—how cheapa. (Pashun paints in black: "This is a cheap barber shop;" then in brown: "Da gooda da haircut—10 cents.")

Tony: (Gesturing.) Da price, she too low.

Pashun: (Paints "15 cents.")

Tony: Da price, she still too low.

Pashun: (Paints "18 cents.") How's that?

Tony: (Gesturing more excitedly than ever.) I gotta to live—gotta eat—you drawa da trade but I losa da money. Da soap, da towel, is costa me money.

Pashun: Ah, grand and glorious barber of the west, I will fix it. (Paints 20 cents.)

Tony: (Greatly excited.) You alla wet—make it much more. Why, you old dodo of da Orient, my haircuts are wort' more dan dat.

Pashun: I'll fix it for good. (Paints "$10.00.") Is that enough?

Tony: I give up. Painta somet'ing else. (Pashun paints: "Geta Your Hair Tonic Here." Letters of this one are of different colors.)

Tony: At last you getta da idea. Dat is art.

Pashun: (Paints: "Open all night" in different colors; picture of Tony entitled: "Da Barber.")

Tony: You spoila dem all, you bumma artist.

Pashun: I will now show you pictures of my native land. (Picks up large, seemingly blank piece of paper.) Here is my home—this is my favorite camel and these are some of my wives. (Points to blank spaces on the piece of paper.)

Tony: You try to kid me. Da picture she is blank.

Pashun: Ah, then you do not see what I see. Perhaps this will help you. (Light is touched to the lines of especially prepared paper. A piece of paper is mounted on a black silhouette. A drawing is made with a saturated solution of KNO_3. The flame burns out the lines and the inner portion falls out leaving a black silhouette. Be sure to connect all lines in each drawing.)

Tony: You country she notta so bad. But now—now, my great wizard of the scattered sands, I have here what we calla in Italy da balloon. Da balloon is tied shut. Now if you are so wonderful let's see you blow up da balloon.

Pashun: I will show you, my fair barber, how we go ballooning in my country. Knowing the fundamental gas equation $PV = NRT$, P being the pressure, V the volume, N the number of molecules, R a constant, and T the temperature, it is all very simple. (Takes thermometer and pressure gage out of pocket. Regards them carefully. Picks up balloon. Balloon contains calcium carbide and a bottle of water. Stopper is removed from bottle of water and generated acetylene inflates the balloon. As soon as the balloon is inflated, balloons which have been filled with some lighter-than-air gas, and which have been placed around stage, are loosened. The effect should be that of balloons rising all over the stage.)

Tony: Who tolda you to blow up alla da balloons. You losa all my balloons. (Runs about trying to catch them.)

Pashun: (Picks up non-spillable goblet of wine.) My favorite dessert. The water of my country—the elixir of life. (Turns goblet upside down.)

Tony: You thinka you an old sheik. I knowa dat trick. (Holds goblet upside down, wine comes out all over his face. Cork in side of goblet is loosened.)

Pashun: Dog! You waste the joyful liquids.

Tony: Oh, I got lotsa more hair tonic—da gin, da whiskey, da rye, da bacardi. What kind will you have? (Takes down bottle from shelf containing water with one drop of ammonia.)

Pashun: Give me red.

Tony: Red? (Puzzled, Tony gives him dry glass containing drop of phenolphthalein. Pashun pours dilute ammonia into the glass.)

Pashun: To my Harem, to my Caliph, to my Sultan, to myself. (Drinks, makes wry face. Throws rest of drink *but not cup* into receiver. Receiver contains flash powder and blows up.)

Tony: I musta put too much yeast in that one.

Pashun: (Slightly drunk.) Give me white.

Tony: (Pours Pashun a glass full of water.)

Pashun: To the land of the burning sand. To the Eastern rolling dunes of Silicon. To the house of Nuc-de-din and Enis-el-jelis. To my favorite wife. (Drinks, makes wry face, throws rest of drink *but not cup* into receiver, receiver blows up as before.)

Tony: I musta put too much yeast in that one, too.

Pashun: (Very drunk.) Give me blue.

Tony: Well one t'ing—he's da patriot. (Pours drink—glass contains drop of methylene blue.)

Pashun: Her skin is like silk, and her speech is soft, neither redundant nor deficient. Her eyes, God said to them, be, and they were, affecting men's hearts with the potency of wine. May my love for her grow more warm each night. (Drinks, pretends to throw remainder of drink in receiver but does not. Receiver goes off as before.) Ha! Ha! I fooled you that time. (Drinks remainder and tramps on $KClO_3$ and red phosphorus at his feet. Looks frightened and feels stomach.)

Tony: I musta put too mucha somet'ing in dat one, too.

Pashun: (Drunk.) I make everything blow up. (Points to flower pot—flower pot blows up. At this point charges of flash powder which have been set in urns and at various places blow up. Streams of titanium tetrachloride smoke are blown out. Several buckets of water, etc., are dumped. This action is rapid. Tony looks frightened —Pashun laughs.)

Tony: The War, she begin to start. (Snatches up R. O. T. C. coat and rifle—puts on tin helmet—Orchestra plays "Over There" or some other war-time music.)

(CURTAIN)

Directions for Tricks Used

Matches: Coat a splint with molten sulfur and sugar and then with a large amount of $KClO_3$. NOTE: *Handle with care.* To light, just touch the end with concentrated sulfuric acid.

Sawdust and Na_2O_2: Mix equal portions of sawdust and Na_2O_2. A few drops of water will be sufficient to make the sawdust catch on fire.

Inflammable Liquid: This liquid contains 60% CS_2 and 40% CCl_4. Be sure to test this liquid before it is used.

Time Reactions: For the blue, pour an aqueous solution of sodium sulfite and sulfuric acid into an aqueous solution of iodic acid containing some "soluble" starch.[2] For yellow, use a sodium arsenite solution acidified with 2 molar acetic acid and a sodium thiosulfate solution. The solutions may be mixed and poured into the bottles offstage at a given cue and placed upon one of a set of shelves from the back. The end of the set of shelves should face the audience. Careful rehearsal is necessary to secure proper timing.

Flash Powder: $KClO_3 + 3Mg \longrightarrow 3MgO + KCl$. Use proportions indicated by the equation. Mix well and *handle with care.* Fuses for the flash charges may be made with fine iron wire. The electrical circuit used to set off the flash is connected with a storage battery or house current and a switch. The circuit is closed with a piece of the fine iron wire. When the switch is closed the iron wire melts, setting off the flash powder. If house current is used the house fuse must have a higher melting point than the flash fuse.

Special Candles: The wicks of the candles are coated with molten $KClO_3$. When touched with phosphorus the candles will light. This trick may be performed more readily by using gas pilot lights which look like candles. This eliminates the danger of handling phosphorus.

Hydrogen and Oxygen: $2H_2 + O_2 \longrightarrow 2H_2O$. Use proportions as indicated by the equation. Run a mixture of these gases into soap bubbles. Use only a small amount. *Be careful.*

Sign Painting: For yellow, paint the desired sign with $CdCl_2$. When you desire the letters to appear dip a paint brush in ammonium sulfide and run it over the sign. For brown, use $PbCl_2$; for red, phenolphthalein and NH_4OH. For best results use brown, black, and red.

Fire Pictures: Draw the pictures with a saturated solution of KNO_3. Be sure to connect all lines.

White Phosphorus and CS_2: Make up a solution of phosphorus in CS_2. Pour this solution on filter paper and when the CS_2 evaporates the paper will catch fire. *Note:* This is a dangerous mixture—do not get it on the flesh or clothing.

[2] Biltz, "Laboratory Methods of Inorganic Chemistry," John Wiley & Sons, New York, second edition, **1928,** p. 120.

Magic Balloon: Put some calcium carbide and a stoppered bottle of water into a strong balloon. Tie the balloon shut. When the stopper is removed from the bottle of water the generated acetylene will inflate the balloon.

Magic Wine: For red put one drop of phenolphthalein in a dry beaker. To a beaker of water add one drop only of 20% NH_4OH. This is sufficiently alkaline to give a red color with phenolphthalein, but is so weak that it can hardly be tasted. For blue, use one-half drop of C.P. methylene blue in a dry beaker.

Red Phosphorus and Potassium Chlorate: This is a dangerous mixture and must be mixed only in small quantities on the spot where it is to be trodden on. Do not touch this with the hands.

Identifies Precious Stones by Spectroscope. Identifying precious stones by means of the varied rainbow patterns they throw when examined under a "micro-spectroscope," may supplant the time-honored acid tests now employed by gem dealers.

Dr. Edgar T. Wherry, of the U. S. Bureau of Chemistry and Soils, who has developed this unique test, will describe the phenomena revealed by the different stones in an article to be published soon in the *American Mineralogist*. In connection with the article he will present hitherto unpublished tables, giving the mathematical measurements of the color and absorption bands for red, blue, and green stones.

The identification, Dr. Wherry explains, is made by means of the very interesting phenomena revealed by the spectroscope. Light thrown by the gem is broken up into its component parts of red, orange, yellow, green, blue, and violet, the colors being arranged in the order of their wave lengths as in the rainbow. The width and the color of the bands vary with the different mineral substances, and the black absorption bands between the colors likewise vary, both in width and intensity.

A red stone, for example, might be glass, garnet, synthetic ruby, or ruby, worth from ten cents to two hundred dollars. The spectroscope, inserted in the eyepiece of a microscope, quickly analyzes the light from the stone, arranging the color bands and black absorption bands in a pattern that reveals the true composition without possibility of error, because the patterns for no two gems are alike.

Dr. Wherry states that as far as clear, colored stones are concerned, such as rubies, sapphires, and emeralds, the new test is far more certain than the old methods of subjecting the stone to acid or scratching them with minerals, which often injure the jewel. In a spectroscope test the stone does not even have to be removed from its setting and even a minute fragment can be identified.—*Science Service*

Government Urges Caution in Handling "Dry Ice." The number of claims which have been filed with the Ohio Industrial Commission for injuries received while using frozen carbon dioxide, or "dry ice," for industrial purposes, has caused the U. S. Government to issue a warning to workers handling this product.

The "dry ice" has recently come into extensive use for commercial purposes, especially in ice-cream and dairy plants. Its temperature is about 110 degrees below zero or 140 degrees below the temperature of ordinary ice. Although it looks harmless enough it can do considerable damage to the person who handles it with bare hands. Numbness and pain, not only in the fingers but also in the hands and arms, are the first symptoms, and in some cases a form of neuritis is produced.—*Science Service*

STANDING CONTEST FOR UNDERGRADUATE STUDENTS

Continuing the contest announced in October, the Chemistry Student will offer each month an award of ten dollars to the undergraduate student who contributes the best article during that period. All other contributions deemed worthy of publication will be awarded prizes of five dollars each. Each monthly contest period will begin on the sixteenth of the calendar month and close the fifteenth of the following calendar month.

Papers on any of the following subjects may be entered in the contest:

1. A miniature chemical plant.
2. A chemical play or entertainment.
3. A chemical hobby or project.
4. An unusual and successful chemistry club activity.
5. How we make the programs of our chemistry club interesting.

Occasionally special awards may be made for exceptionally good papers which do not fall strictly within the scope of any of the subjects listed above.

Directions for Contest

1. Type or write legibly on one side of the paper only.
2. If your paper lends itself to illustration, illustrate it with drawings or photographs or both. (As concerns illustrations observe the "Notice to Authors of Papers" which appears at the foot of the table of contents in the front of THIS JOURNAL.)
3. Mark each sheet of your manuscript and each illustration with your name.
4. On a separate sheet of paper give your name, your class, the name and address of the institution at which you are a student, the name of the chemistry club or fraternity at your institution, and the name of the faculty adviser or most active faculty member of your chemistry club.
5. Address contributions to: The Associate Editor, JOURNAL OF CHEMICAL EDUCATION, The Johns Hopkins University, Homewood, Baltimore, Md.

Contributions will be judged on the basis of:

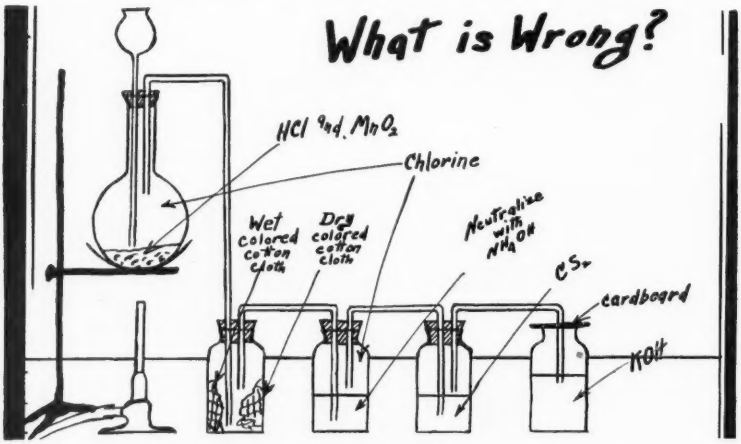
1. Interest
2. Originality
3. Literary excellence
4. Excellence of illustrations (if any)
5. Neatness and legibility.

An article says that chemists have found xylose in peanut shells. Very disheartening, we should think, if they were looking for peanuts.—*Detroit News*

A CONTEST FOR HIGH-SCHOOL AND FRESHMAN STUDENTS

On this page is reproduced the second of a series of drawings prepared for us by Prof. John J. Condon of William Nottingham High School, Syracuse, New York. Write a brief statement, telling what is wrong with the picture. Use complete sentences; do not merely list mistakes. Type your manuscript, if possible; if not, be sure that you write legibly. Type or write on one side of the paper only.

Make a correct drawing, showing the picture as you think it should be. Use black India ink and white drawing paper. (If you believe that you can draw better on coördinate paper, white paper with blue rulings must be used.) Drawings should be approximately 4″ × 6″ or 8″ × 12″.



Place your name at the top of each page of your manuscript and at the top of your drawing.

On a separate sheet accompanying your manuscript write your own name, the name and address of the institution at which you are a student, the name of your chemistry instructor, and the name of the chemistry club at your institution (if there is one).

Address your paper to: The Associate Editor, JOURNAL OF CHEMICAL EDUCATION, The Johns Hopkins University, Homewood, Baltimore, Md.

Your contribution to this month's contest must be postmarked not later than November 15th.

Awards

The best contribution received will be awarded a prize of five dollars and will be published in the January JOURNAL. The five next best

papers will receive awards of one dollar each and the names of the winners will be printed in the January number.

Contributions will be judged on the basis of:

1. Correctness from a chemical standpoint
2. Neatness and correctness of drawing
3. English
4. Neatness and legibility of manuscript.

Papers which do not comply with all of the rules of the contest will not be considered.

Burn Aluminum Dust for Intense Flame. A flame so intense as to melt its way through any known solid substance is produced by a new type of blowpipe, employing finely powdered aluminum instead of the more familiar hydrogen or acetylene gases. The new invention was described recently by Dr. Frank M. Strong of Syracuse University, speaking before members of the American Chemical Society meeting at Minneapolis.

Dr. Strong described his device as follows:

"A screw conveyor carries a slow stream of aluminum dust from the bottom of a hopper out through the open end of a brass pipe. The dust is here met by a swift cross-stream of oxygen, with which it forms a fine and uniform suspension. From this point the mixture is passed forward through a larger tube, which a little farther along is divided up into eight smaller tubes. The latter diverge from the central tube for a short distance, and are then curved back inward so as to come to a sharp focus. The aluminum-oxygen flame can be lighted at this focus point with a match or Bunsen burner."

Dr. Strong's blowpipe combines the principles of the familiar oxyhydrogen or oxyacetylene blowpipes with that of thermite, a powder used for the generation of intense heat on a limited area, such as the ends of rails in welding. Thermite consists of aluminum powder mixed with another chemical which on heating yields free oxygen at a rapid rate. In the new blowpipe the oxygen is supplied directly in the form of a gas instead of being generated on the spot from a chemical.—*Science Service*

Kansas Professor Makes Artificial Diamonds. Artificial diamonds were promised the world by Prof. J. Willard Hershey of McPherson College, Kansas, who spoke recently before the American Chemical Society at Minneapolis.

The most promising modern attempts at achieving this much-sought-for end, Prof. Hershey said, were made about thirty years ago by a French scientist named Moissan. Taking up the work where Moissan left off, the Kansas chemist has made some improvements in his technic and is hopeful of eventually producing good diamonds in the laboratory. His process consists of melting pure carbon with filings of various metals in an electric furnace, and then plunging the white-hot mass into an ice-cold saturated salt solution. The cooled mass is subjected to further chemical treatment, and then tested for diamond particles.

"I have not yet succeeded in all that I hope to accomplish," said Prof. Hershey, "but the largest diamonds produced at McPherson College are the largest genuine synthetic diamonds on record. It is no longer an unattainable goal to produce artificial diamonds in the laboratory, and it is believed that the difficulties that prevent the preparation of large and beautiful diamonds are only technical."—*Science Service*

THE LIBRARY

POPULAR SCIENCE, *September, 1929*

(*P. 22.*) "Cheaper Power from Quicksilver." *Grover C. Mueller.* Turbines employing mercury vapor instead of steam have reached the stage of successful operation on a commercial scale. The mercury turbine operates more smoothly and efficiently than the steam turbine. A further efficiency feature is that the mercury condenser is used as a steam boiler which drives an auxiliary steam turbine. The chief disadvantage of the mercury turbine is the high initial cost; more than a thousand gallons of mercury (nearly seventy tons), at about $200 per gallon, are necessary to operate the Hartford Electric Light Company's 13,000 horsepower plant at South Meadow. (Illustrated.)

(*P. 48.*) "New Sources of Gasoline." The Standard Oil Company of New Jersey has begun construction of a plant which will employ the recently developed catalytic hydrogenation process for the production of gasoline from petroleum. The new process is said to yield 100% gasoline as compared to 40% obtained by the cracking process. The Bergius process, developed in Germany, produces gasoline from powdered soft coal by another hydrogenation process. In Scotland some petroleum is being produced from shale. Large deposits of this rock in Colorado and Utah may prove one of America's chief future sources of oil.

(*P. 60.*) "New Oxygen Tent to Save Pneumonia Victims." The newly devised "oxygen tent" makes it possible to supply a higher oxygen concentration to a pneumonia patient, thus cutting down the rate of breathing and conserving the patient's strength. (One illustration.)

(*P. 60.*) "Poisons Cause Plants to Sprout and Bloom." Experiments at the Boyce Thompson Institute for Plant Research show that certain poisonous chemicals are capable of reducing the dormant periods of various plants, thus causing them to sprout much sooner than they otherwise would. Sometimes the treatment results in increased productivity as well as earlier sprouting.

(*P. 63.*) "Dead Sea Contains Gold Worth Fifty Billions." Recently Dr. Georges Claude has reported that in addition to deposits of potash, bromine salts, gypsum, magnesium chloride, and other minerals, the Dead Sea contains about fifty billion dollars' worth of gold. He estimates that approximately one-third of the precious metal could be extracted in about fifteen years, by means of modern scientific methods.

(*P. 66.*) "Aluminum Replaces Wood in Office Chairs." An aluminum alloy with a strength approximately that of mild steel is being used in the production of office furniture which weighs only about half as much as the customary wooden furniture.

(*P. 66.*) "Strange Mineral Produces Useful 'Offspring.'" Bentonite

(a plastic clay which has the property of swelling to many times its normal volume on the addition of water) is finding many new uses. It will filter crude petroleum more quickly and cheaply than fuller's earth; it is useful in renewing used molding sands in foundries; it is employed as an ingredient in soaps, cleaners, and beauty preparations, in insecticide emulsions and in surgical dressings. It can also be used as a plastic filler in linoleum, window shades, and phonograph records.

(*P. 68.*) "Onions Their Own Doctors." Recent analyses at the University of Wisconsin show that red and yellow onions secrete an acid of the phenol series which is effective in protecting them against parasitic fungi. White onions are not so protected.

(*P. 114.*) "Home Workshop Chemistry." Directions for removal of "frozen" glass stoppers. Directions for care and use of cork stoppers.

October, 1929

(*P. 29.*) "Plant 'Pills' Grow Bumper Crops." *H. H. Dunn.* This article describes some of the results obtained from some five thousand experiments conducted over a period of five years under the direction of Dr. W. F. Gericke, head of the department of plant physiology of the University of California. Plant "pills" or capsules containing properly proportioned doses of seven essential plant-food elements are applied to plants grown either in soil or in water. This treatment enables the grower to support more plants upon a smaller area than heretofore, increases the productivity of the plants as well as the size and quality of the flowers and vegetables produced and shortens the growing season. The water culture requires only a moderate investment for concrete tankage and actually requires less water than is necessary under ordinary soil cultivation conditions. There is no necessity for cultivation or weeding, and trouble with insects and diseases is appreciably reduced. Dr. Gericke believes that the water culture will prove of greatest value in arid regions where irrigation would be necessary to support plant life. (Well illustrated.)

(*P. 42.*) "Everyday Wonders in Colloid Chemistry." *E. E. Free.* The author cites instances of the applications of colloid chemistry to everyday life—instances too numerous to note in detail here. He then explains the nature and some of the chief characteristics of colloidal systems and describes some of the methods and instruments employed to study them. A number of practical applications are then discussed in the light of the principles already outlined. A good popular article. (Illustrated.)

(*P. 46.*) "Guarding Buildings from Decay." Chemists of the British Government recently advised owners to wash stone buildings occasionally with hot water and soap to remove accumulations of soot and condensed acid gases which attack stone and mortar.

(*P. 47.*) "Farming for Chemicals." Some examples of the present chemical utilization of farm wastes are cited and it is predicted that agriculture will tend more and more in the future toward the production of raw materials for chemical processes.

(*P. 48.*) "Cathode Rays Test Gems." Not only may natural sapphires be distinguished from synthetic stones, but the geographical sources of natural sapphires can often be determined by the nature and persistence of the glow induced by bombarding the gems with cathode rays. The item includes a brief discussion of the nature of cathode rays and of the apparatus used to produce them. (Illustrated.)

(*P. 49.*) "Sunshine in Yeast." Yeast is now added to the number of foods which are irradiated with ultra-violet light to produce "Vitamin D."

(*P. 57.*) "New Scientific Refrigeration." *Robert E. Martin.* "Quick-freezing" has made possible the preservation of animal tissues, notably fish, in excellent condition for long periods of time. Earlier attempts to preserve such foods by freezing were unsuccessful for the reason that the slow methods of freezing employed resulted in the formation of large, sharp needles of ice within the cells of the tissues. The needles punctured the cell walls with the result that, upon thawing, the flavor and nutritive substances leaked out and bacteria found ready entrance. When fish or meats are submitted to extremely low temperatures (—45°F.) they freeze very rapidly with the formation of crystals which are too minute to injure the cell walls. This and other improvements in refrigeration and the handling of refrigerated products are revolutionizing our perishable foodstuffs industries. (Illustrated.)

(*P. 63.*) "Erased Writing Revealed by Ultra-Violet Rays." Because of its cost and scarcity parchment was often erased and re-used two or three times by the scribes of the Middle Ages. Sometimes the erased writing is of more interest to the historian than that now visible. Professor G. R. Köbel, of the University of Vienna, has found that by means of ultra-violet light the invisible writings may often be photographed and deciphered.

(*P. 64.*) "Paper Made Fireproof by New Secret Chemical." Two Los Angeles experimenters have evolved a process for fireproofing paper and wood by soaking in a secret chemical preparation. The inventors claim that wooden structures can be made as resistant to fire as stone buildings. (One photograph.)

(*P. 64.*) "Eggs, Beans, and Milk Cause Strange Ailments." Abnormal protein sensitivities, such as make some people subject to hay-fever, are responsible for such disorders as purple spots on the skin which some persons suffer after eating eggs, beans, or milk.

(*P. 67.*) "'Dry Ice' Offers a New Remedy for Leprosy." A new leprosy cure which avoids some of the disadvantages of the chaulmoogra

oil treatment has been developed by Dr. A. Paldrok, a skin specialist at the University of Dorpat in Esthonia. By this method areas of infected skin are frozen with solid carbon dioxide. The tissues so killed are said to discharge into the blood chemical substances which stimulate the body to repel scattered leprosy germs. Gold compounds are also used in the treatment.

(*P. 70.*) "How Much Do You Know about Photography?" Ten questions on photography. Answers are given on p. 156.

(*P. 114.*) "Home Workshop Chemistry." Directions for the cleaning and polishing of metals, with formulas for polishes.

(*P. 152.*) "Gems Made to Order in Chemist's Laboratory." A French chemist, Louis Nolet, is reported to have discovered a new process for the synthetic manufacture of precious and semi-precious stones, including emeralds, rubies, sapphires, opals, amethysts, and topazes, as well as marble, jet, and jade.

THE SCIENTIFIC AMERICAN, *September, 1929*

(*P. 208.*) "Licorice the Versatile." The licorice root has been a well-known and highly esteemed commodity since times almost as far back as recorded history extends. It is still a useful item in the pharmacopœia and a wholesome confectionery ingredient. The main sources of licorice root are Spain, Italy, Greece, Asia Minor, Russia, Persia, and China, and a year's production sometimes exceeds one hundred million pounds. Licorice reaches the market in the form of powdered root, "powdered licorice extract," licorice "paste," and licorice "syrup." The fibrous residue remaining after extraction of the licorice root is now converted into insulating and building boards, as well as into cardboards for special purposes. Another interesting and important by-product is the high-foaming derivative which makes possible the "Foamite-Firefoam" method of extinguishing fires—particularly oil fires. (Illustrated.)

(*P. 212.*) "Why Does an Oil Gusher Gush?" *Arthur P. Woollacott.* The pressure which brings oil to the surface in an oil well is gas pressure. Even where resort is had to pumping, there must be sufficient gas pressure to force oil out of the oil-bearing sands into the well. Oil does not lie in subterranean lakes. The problem of maximum oil recovery is therefore a problem of gas conservation. Producers are beginning to realize this fact and are even turning gas back into exhausted fields. Here the gas cannot only be held in natural storage, but it helps to recover a great deal of oil which would otherwise be lost forever to human use. (Illustrated.)

(*P. 240.*) "World's Largest Vineyard Uses Machinery and Chemical Control." Guasti, California is a town of 2500 inhabitants, all employed in the grape industry. Over 500 varieties of grapes are grown on land

which was originally desert. About half the product is shipped out as fresh fruit, the remainder being converted into grape juice, legal wines, medicinal tonics, and cooking sauces. The story is told chiefly by means of photographs and descriptive captions.

(*P. 245.*) "The 'Heat Makes Cold' Refrigeration Unit." A description of the "Icyball" absorption refrigeration unit which was mentioned in the October JOURNAL, pp. 1772–3. (Illustrated.)

(*P. 246.*) "Self-Lighting Cigarettes." Miss Annella Wieben and Dr. F. E. Brown of the faculty of the Iowa State College have recently invented a cigarette with a tip which, when rubbed upon an especially prepared surface, will light, even in a high wind. It is claimed that the new tip gives off no harmful or unpleasant gases, thus overcoming a serious objection to previous attempts to produce self-lighting cigarettes. (One photograph.)

(*P. 250.*) "Arsenical Poisoning." Drs. Theodore L. Lewis and Lewis Gunther have recently completed an investigation which adds to previous knowledge on the subject of arsenic poisoning. They note that arsenic occurs in greater relative concentrations in the hair than in any other part of the body. (One photograph.)

(*P. 250.*) "The Danger of Ethylene." According to information acquired by Dr. Moses Salzer through answers to a questionnaire submitted to nearly five hundred hospitals, the danger from possible explosions of ethylene used as an anesthetic has been greatly overestimated. Actual experience shows ethylene to be somewhat safer than ether.

(*P. 250.*) "Sensitivity to Food." It has long been known that some persons are sensitive to certain foods and suffer various discomforts when they indulge in them. Drs. H. L. Alexander and C. H. Eyermann of St. Louis have recently reported on six new cases of this type. These cases are briefly described.

(*P. 252.*) "Chemistry in Industry." The following items are included: Hydrogenation Comes to Revolutionize Gasoline Production; Organic Substances Reduce Boiler Scale; Investigate New Sources of Potash; Abietic Acid Crystals (two photomicrographs); Chemistry Contributes to Improved Explosives (illustrated); New Protective Coating Has Rubber Base; Smoke Encourages Pneumonia; Fluorine Commercially Produced; Caustic Soda Made by Use of Fluorine.

October, 1929 (Aviation number)

(*P. 288.*) "Seeking Genius." The editor comments upon the Chair of Chemical Education recently established at the Johns Hopkins University through the financial support of Mr. Francis P. Garvan, and upon the selection of students of exceptional promise for training in chemistry. [See THIS JOURNAL, **6**, 319–22 (Feb., 1929)].

(*P. 342.*) "New Synthetic Rubber Is Made Largely of Waste Materials." Description of a new "synthetic rubber" and of the results obtained from a test set of solid truck tires. The statement of the ingredients entering into the product is so vague and generalized that no idea of its composition can be formed. It is said that "rubber" paving blocks can be produced at an attractive price. (Illustration.)

(*P. 348.*) "Chemistry in Industry" includes the following titles: Sionon—a Sugar Substitute; Petroleum Products in Insecticides; Silver as a Purification Agent; Chlorine Carrier; Bentonite Suitable for Pencil Leads; Pure Zinc; Modern Auto Uses over 100 Chemicals; Soap Dust Found to Be Highly Explosive; Nickel Welded with Flux in Flame; Industry Developed to Use Waste Straw.

SCIENCE AND INVENTION, *September, 1929*

(*P. 418.*) "Is a College Education Worth While?" Brief opinions by W. O'Neil, President of the General Tire and Rubber Co.; Frank Melville, Jr., President of the Melville Shoe Corporation; Edwin Franks Goldman, Musician, Conductor, and Composer; Prof. Thomas Nixon Carver, of Harvard University.

(*P. 426.*) "Experiments with Little-Known Chemicals." *Dr. Ernest Bade.* Directions for the preparation of acetamide and of methyl and ethyl amines and for the carrying out of a number of characteristic reactions of these compounds.

POPULAR MECHANICS, *September, 1929*

(*P. 366.*) "New Plant Yields Three Valuable Products." Brotex, a plant evolved by an English scientist, attains maturity in twelve to eighteen months, when it is eight to ten feet high and has a stem ten inches in diameter. It yields fiber for textiles, wood cellulose from its core for paper making, and seed for the manufacture of cattle feed. Profit from the crop has been estimated at about $250 an acre.

(*P. 400.*) "Squeeze Chemicals from Gas under High Pressure." High pressure experiments at the University of Illinois are being conducted with a view to the production of industrial alcohol from water gas, and of acetic acid from methyl alcohol. Synthetic oil of bitter almonds (benzaldehyde) has already been produced from carbon monoxide and benzene. (We consider it highly improbable that the investigators are attempting to convert CO_2 into sulfuric and other mineral acids, as the item states.)

(*P. 432.*) "Nitroglycerine Is Used as Lubricant." Nitroglycerine is a substance ordinarily handled with extreme care and respect—and rightly so. There are, however, cases on record where it has been used

by mistake as a lubricant and as a dressing for leather boots, and with no disastrous results.

(*P. 456.*) "Naphtha Deadly as Dynamite When Mixed with Air." Naphtha,[1] benzine,[2] and gasoline vapors are all highly explosive when mixed with air. It is said that one gallon of naphtha, evaporated and mixed with air in the proper proportions, is as dangerous as seventy-five pounds of dynamite. (Incidentally, it will explode on much slighter provocation.) Sources of danger to be avoided include, not only open flames, but static electricity. Sometimes sufficient charges are developed by straining the solvents, or by the rubbing incident to the washing of silk or wool garments to cause sparks which will explode the vapors. Grounding of solids likely to develop charges is a wise precaution.

(*P. 458.*) "Dead Sea to Yield Billions in Mineral Treasures." A syndicate has lately closed a contract with the British Government to develop the vast mineral resources of the Dead Sea. It is estimated that the waters contain 2,000,000,000 tons of KCl, six times as much NaCl, as well as large amounts of magnesium and calcium salts and gold to the extent of fifty billion dollars. Costs of production by solar evaporation will be low but transportation presents a problem.

October, 1929

(*P. 541.*) "Removes Poison from Drugs." The title is rather misleading. We gather from the text that small quantities of a lipoid have the property of suppressing some of the undesirable effects of such drugs as those contained in coffee, tobacco or morphine, so that only the desired effects are obtained. The method of administering the drug and the lipoid is not stated, nor is the lipoid used designated. The discovery is attributed to "a German scientist."

(*P. 545.*) "Aluminum Covers for Books Resist Tropical Heat." In some parts of Africa the air is so dry that ordinary book covers warp and turn back. The new aluminum cover has about the thickness of the metal in an ordinary tin can and is chemically treated to take ordinary printer's ink as well as enamel or paint.

(*P. 560.*) "Black Fence Post Turns White Every Night." One of the earliest examples of the phenomenon known as "phototropy"[3] was that of a gate-post which the owner had painted *white* (not *black* as is stated in this item), but which appeared black by daylight and white only at

[1,2] Naphtha and benzine are petroleum solvents similar to gasoline, but of lower boiling point, falling within the distillation range usually designated as "petroleum ether." They should not be confused with naphthalene ($C_{10}H_8$) or benzene (C_6H_6), respectively.

[3] Phototropy is the term applied to reversible color changes induced by light. A phototropic substance changes color when exposed to light but returns to its original color in near-darkness.

night. No entirely satisfactory explanation of phototropy has as yet been evolved. Most of the known phototropic systems are solutions of colorless derivatives of certain dyes.

(*P. 585.*) " 'Dry Ice' Cause of Injuries." Careless handling of solid carbon dioxide with the bare hands has led to injury through freezing of the fingers.

(*P. 592.*) "Dyed Goose Feathers Puzzle Custom Chemists." The Customs Service relies upon chemists and microscopists to identify and classify properly many of the unusual imports which pass through its hands. Often the amount of duty to be paid depends upon the material of which an article is constructed or upon whether or not it is an antique. These questions the laboratory must answer.

(*P. 594.*) "On the Trail of Poison Mysteries." *Paul D. Paddock.* Police departments are installing laboratories where such apparently trivial things as spots on clothing, weapons, or money frequently provide the final evidence that may free or convict the accused. The chemist can determine whether spots have been made by blood and if so whether or not the blood was human blood. Analysis of mud-stains on shoes, clothing, or automobiles will sometimes upset alibis. The hundred or more common poisons can all be reliably identified, even at periods long after death and burial. Microscopy and physics supplement chemistry. (Illustrated, though not all of the illustrations are strictly relevant to the text.)

(*P. 600.*) "Hardened Aluminum Will Not Stain or Tarnish." Durability of aluminum is increased by a recently developed treating process which not only hardens the metal but also eliminates the tendency of the surface to smudge, tarnish, or scratch, and enables it to resist the effects of salt water and various acids and corrosive agencies.

(*P. 640.*) "Gas Is Stubborn Prisoner Aboard Airships." One of the difficulties encountered in the development of such airships as the Los Angeles and the Graf Zeppelin is that of confining the gases which furnish the lifting power. Hydrogen and helium, both light gases, diffuse comparatively rapidly through even the most impervious fabrics. One of the most satisfactory containing materials yet discovered is goldbeater's skin. Gas cells are constructed from the skins cemented to an especially prepared cloth base.

Paper from Bamboo Produced in India. A process developed by experiments in India by which white paper of an excellent quality can be made from bamboo is attracting interest, according to W. H. Minor, vice consul at Calcutta. Some progress is already reported in the commercial application of the new material for paper, and the formation of a company is being considered in England.—*News Ed., Ind. Eng. Chem.*

THE A. C. S. PRIZE ESSAY CONTEST

Last month (pp. 1805–6) we published a preliminary announcement of the continuation of the A. C. S. Prize Essay Contest and presented a list of the essay topics selected by the Committee on Prize Essays for 1929–30. The rules for the high-school and for the university and college freshman contests appear herewith.

University and College Freshmen

PRIZES

Six prizes of $500, six prizes of $300, and six prizes of $200, will be awarded to freshman students of colleges and universities in the United States who write the first, second, and third best essays, respectively, on each of the six subjects assigned.

RULES

1. A contestant must confine his essay to one of the five topics set out after each general subject listed. [See THIS JOURNAL, **6**, 1805–6 (Oct., 1929)].
2. For the purpose of this contest an undergraduate freshman student shall be a student who has satisfied college entrance requirements, is enrolled in such an institution, and is continuing the regular work of a first-year collegiate grade.
3. A contestant may submit only one essay.
4. **Essays must not exceed 2500 words. Any essay containing more than 2500 words will be rejected without reading.**
5. Essays must be typewritten, double-spaced, have wide margins, and be on one side of paper $8\frac{1}{2}''$ x $11''$. The sheets must be numbered consecutively and securely fastened together. If typewriting facilities are not available, then legible, handwritten essays should be substituted. Illegible essays will not be accepted.
6. **A plain sealed envelope firmly attached to the essay must contain the full name of the contestant, the correct name and address of his school, his home address, and the exact number of words in his essay. No other identification of the writer of the essay must appear, either on the essay itself or the envelope.**
7. All direct quotations must be enclosed in quotation marks and due credit must be given to sources of reference. Lengthy quotations must not be included.
8. Exhibits or illustrations must not be made a part of, or accompany an essay.
9. Duplicates of essays submitted in former contests will not be accepted.

10. Essays must be in the hands of the Secretary, Committee on Prize Essays, American Chemical Society, 654 Madison Avenue, New York City, not later than March 1, 1930.
11. By the act of entering an essay in the contest, the writer gives to the Committee on Prize Essays of the American Chemical Society full right to its permanent possession, publication rights, etc.
12. The University and College Freshman Contest is a national contest and all matters pertaining to it should be referred directly to the Committee on Prize Essays of the American Chemical Society, 654 Madison Avenue, New York City, which will be assisted by designated individuals and committees.

The examination of all essays submitted and the selection of the prize-winning essays will be in the hands of the Committee on Prize Essays of the American Chemical Society.

Winners will be notified as soon as practicable after March 1, 1930.

High and Secondary School Students

PRIZES

The National Prizes are six four-year scholarships at any recognized college or university in the United States, each providing tuition fees and $500 in cash annually.

The prizes for each of the fifty-one separate contests conducted in each State, the District of Columbia, Alaska and Hawaii as a unit, and Porto Rico and the Philippines as a unit, are six $20 gold pieces, one for each subject given below, and six certificates of Honorable Mention.

RULES

1. Any student enrolled in any high or secondary school in the United States, who has not completed sufficient work to satisfy college entrance requirements, is eligible to enter the Contest. Students who will graduate at mid-year may enter. It is not necessary to be enrolled in any chemistry courses, or to have studied chemistry previously.
2. A contestant may submit only one essay.
3. Essays must not exceed 2500 words.
4. Essay must be the original work of the contestant and must be confined to one of the (general) subjects listed. [See THIS JOURNAL, **6,** 1805–6 (Oct., 1929)].
5. Essay must be typewritten, double-spaced, have wide margins, and be on one side of paper $8\frac{1}{2}'' \times 11''$. The sheets must be numbered consecutively and securely fastened together. If typewriting facilities are not available then legible, handwritten essay should be substituted. Illegible essays will not be accepted.

6. **A plain sealed envelope firmly attached to the essay must contain the full name of the contestant, the correct name and address of his school, his home address, and the exact number of words in his essay. No other identification of the writer of the essay must appear, either on the essay itself or the envelope.**
7. All direct quotations must be enclosed in quotation marks and due credit must be given to sources of reference. Lengthy quotations must not be included.
8. Exhibits or illustrations must not be made a part of, or accompany an essay.
9. Duplicates of essays submitted in former contests will not be accepted.
10. Essays must be received at the office of the Chairman of the State Awards Committee on or before March 1, 1930. Essays may be submitted through school authorities or individually. In the latter case a statement from a school official or teacher regarding enrolment should accompany the essay.
11. By the act of entering an essay in the contest, the writer gives to the Committee on Prize Essays of the American Chemical Society full right to its permanent possession, publication rights, etc.

Requests for the rules of the Normal School Teachers' College contest or for further information about any of the contests should be addressed to Paul Smith, Secretary, 654 Madison Avenue, New York City.

Faraday Electromagnetic Centenary. The arrangements initiated by the Royal Institution of London for the celebration of the centenary of Faraday's discovery of electromagnetic induction have already been announced. At the representative meeting held at the House of the Institution on February 5, 1929, the formation of two committees was agreed to, and these committees are now at work. The first, consisting of representatives of the Royal Society, the British Association, and other scientific societies, as well as the Royal Institution, is concerned with the purely scientific aspects of Faraday's work in relation to the proposed celebrations; the second committee, which has been called together by the Institution of Electrical Engineers, consists of representatives of the principal organizations of those industries which have risen in the past hundred years upon the scientific foundation of Faraday's discoveries, and is dealing with the industrial aspects of the celebrations. The two committees are working in close coöperation; the preliminary discussions which have taken place indicate that the significance of the centenary is very widely appreciated and that the celebrations are likely to arouse world-wide interest and support. The dates have now been fixed, and the proceedings will commence in London on Monday, September 21, 1931. Further, an intimation has been received from the British Association that its centenary meeting will be held in London during the week commencing September 23, 1931. These two centenaries, with important electrical conferences and other events which are to take place about the same time, will thus conjoin to make the year 1931 a memorable one in this and every country where the genius of Faraday has borne fruit.—*Chem. Age*

Chemical Digest

THE NEW INTRODUCTORY CHEMISTRY. PART II

A. T. Bawden, Shanghai Baptist College, Shanghai, China

The Place of Experiments in the New Introductory Chemistry

We have tried giving the course with individual laboratory work, and with lecture demonstrations only. The results show that for the majority of the students in such a course the latter plan is most effective. As Powers[32] says:

> It is important for the beginner to have laboratory work. Whether he does the laboratory work himself, or sees some one else do it, may not be material; but he must be acquainted with the processes by which it is done.

A review of the published investigation of the relative values of the lecture-demonstration, and individual laboratory method of instruction in a beginning science course indicates that the former method is best. For example: Fred G. Ambel[33] shows that the lecture demonstration method takes less time and money than the individual laboratory method and that the brighter students profit most from the demonstration method.

Carpenter[34] shows that in his experiments the majority of students in high-school laboratory chemistry classes succeed as well by the demonstration method as by the individual experiment method.

Pugh[35] shows that the lecture-demonstration method is 10% more efficient than the individual laboratory method.

Walter W. Lucasse[36] shows that there is no unanimity of opinion even among chemists as to the place of laboratory work.

W. W. Knox[37] also shows that the demonstration method rated higher than the laboratory method for immediate retention, delayed retention, and method of attack.

Downing[38] finds that:

[32] "Some Educational Values in Laboratory Work," *Education*, **44**, 546–55 (1924).

[33] *J. Educ. Rev.*, **13**, 355–65 (1926).

[34] This Journal, **3**, 798–805 (July, 1926).

[35] *H.-S. Teacher*, **3**, 384–6 (1927).

[36] "The Possible Over-Emphasis of Laboratory Instruction in Higher Institutions," This Journal, **5**, 142–50 (Feb., 1928).

[37] *Sch. Rev.*, **35**, 376–86 (1927).

[38] "A Comparison of the Lecture-Demonstration and the Laboratory Methods of Instruction in Science," *Ibid.*, **33**, 688–97 (1925).

The lecture-demonstration method of instruction yields better results than the laboratory method in imparting essential knowledge and is more economical of time and expense.

Herbert R. Smith[25] [THIS JOURNAL, **2**, 231–4 (Apr., 1925)] says:

The laboratory method that most science instructors instinctively hold in mind may be summed up by the sentence, *The pupil experiments and finds out for himself.* This condition is apparently satisfactory, but the first part of the statement is the only certain accomplishment.

Mr. Smith has found that the satisfactory solution of the problem is a combination of teacher-pupil laboratory work, allowing those students who have the ability of inclination to work alone.

For further material in support of this view, see "Investigations in the Teaching of Science," pp. 49–51.

A large number of letters were written to our leading chemistry teachers concerning the problem of laboratory work in an appreciation course. We are quoting portions of a few of these letters, because of the wealth of teaching experience which they reveal.

From a past-president of the American Chemical Society:

Your letter of November the 28th raises a very interesting question, to which I have not given careful thought. For a long time I have been convinced that students who are to have but one course in chemistry should receive instruction along entirely different lines from those commonly followed in the usual course of first-year chemistry; and I am glad to see that you are developing a course of this nature. At present, my view is, that with the limited amount of time it is better not to take any of it for experimentation by students. If this course is followed, there should be, however, special attention to lecture demonstrations which illustrate the principles considered. I think the student would profit more by seeing an important experiment performed and fully discussed in the classroom than by carrying out, in a superficial way, a similar experiment where he probably would miss the lesson to be drawn from what is observed. With but a short time devoted to laboratory work a student can acquire no skill in handling laboratory chemical apparatus, and cannot develop very fully keenness of observation and an ability to reason from observation. I think he could gain the latter important things in a classroom demonstration, if the instructor is careful to see that the students get all that is possible from the demonstration. Such a procedure would involve, I think, a new type of classroom instruction and it would be interesting, I think, to have the opportunity as a teacher to develop such work. For example, the experiment might be performed and the students asked to write a description of the results of the experiment before any explanation from the teacher. The teacher could then tell what he has observed and the student would find out how adequately he (the student) had seen what was going on before him. I think such instruction should be very informal and the student given the opportunity to talk.

From the head of a state university chemistry department:

So far as possible, it seems to me that both the recitation and laboratory work should emphasize matters in which the students are interested and should by no means be confined merely to their experiences in the chemistry building.

From a prominent organic chemistry teacher:

I would not think, however, that a laboratory course of the type that usually accompanies a beginning course in chemistry would be hardly necessary or suitable. It would seem as if a little first-hand experience with some of the things that are not in their chemistry might be more advisable and would enable them to get a more accurate idea of its real scope. One of the problems met in chemistry is to show its relation to everyday affairs and to make the student appreciate the fact that chemical reactions occur outside, as well as within, the laboratory—that sodium bicarbonate in the kitchen is the same product that is met in the laboratory.

If I were giving a course such as you suggest, I would be strongly inclined to put in one laboratory period every two weeks which would be designed to illustrate, in a moderately simple way, some of the things discussed in the class. These people need to realize that a chemical laboratory is not an especially mysterious place and that chemical substances are very much like the things they might run across elsewhere every day.

Naturally your course would be illustrated with lecture experiments, but I doubt whether such experiments fully take the place of a little first-hand experience.

From the head of the chemistry department in a large college:

I have your good letter of a few days ago, and I am interested in your question. It is one that is bothering us a great deal and I personally have rather strong convictions on this matter. I do believe that we as chemists are rapidly passing the same road that has ruined the teaching of Latin and Greek. These good fellows, well-meaning in every respect, have insisted on teaching their subject as though every student was to be a Greek scholar, whereas I feel sure there is great gain to be gotten from an entirely different approach to the subject. It has very great bearing on the proper understanding of our own mother tongue, but I do not see that every man should be made to read volumes about Homer in order to get this.

Now as chemists we are doing just the very same thing which we have so long thrown up to these men and which we should have sense enough to see has been the downfall of their subject. There is a great deal that folks can learn about chemistry with very little of the real scientific approach that most of us require of our students. In a word, we look upon every student of chemistry as a potential chemist, which is not the truth at all. Nine out of ten of all the students that we have will become average citizens in due time, but not chemistry specialists.

I do believe with all my heart that a very excellent course in chemistry could be designed that would not require laboratory work and that further, it would have as good academic content as the average college course in English, economics, or the like. The knowledge of and about chemistry is certainly not to be had in the laboratory alone. It does teach technic and it does give the student a scientific approach which is most valuable in this day and time, but certainly not essential to the absorption of chemical facts. If I had only one year to take in chemistry, I do not believe I should want to spend half of it in the laboratory. Then too, there is a great deal of useless talk about the lecture system. It is not bad. A good man can teach a student a great many things and can certainly stimulate him into better work and more reading by the lecture system. A poor man cannot teach by the lecture method nor by any other method, as far as that is concerned. Nine out of ten men that write books against the lecture system use it entirely in their own teaching. I had this illustrated only yesterday by a talk with one of these theoretical education experts, who after a long talk in this field admitted that he taught over 200 men in one section by the lecture method.

I do not think that the average chemistry text is at all suited for this kind of course, though a good teacher can work out a good course along with any two or three good

texts at hand. Such a course as the one you have in mind should be very largely organic, for this is the chemistry of life. I do not think it is as hard to teach organic chemistry, the chemistry of one element, with very few theories, as it is to teach the average text in inorganic which is hopeless with the problems and mathematics that they require. No one can doubt the very interesting and direct relation of carbon to our own things of daily life.

Leave out the laboratory and give at least the equivalent amount of time in organic chemistry. I believe, too, that your course should be well illustrated in lecture-table experiments. In a course where laboratory is required *I do not believe in lecture-room experiments.* To see a teacher prepare and test oxygen and then expect a student to get a thrill out of it in the laboratory is too much to expect of any young student. It is like eating stale bread. In my own work, I have entirely cut out the lecture-room experiments. I used to spend more than half my time in this kind of work, but I do no longer think it necessary. In some instances where the work cannot be done by the separate students, I do it for them if it illustrates a principle, as for instance, the beautiful experiment on reaction velocity using sulfurous acid, potassium iodate, and starch as an indicator. Even in this experiment, it is very striking and works beautifully, but does not tell the truth.

Many high-school teachers have definitely proven that these students who have lecture-table experiments and no laboratory work pass better examinations than the other group does. Now do not misunderstand my position. I am not talking about the giving of chemistry as a laboratory science. That is another question and laboratory manipulation as well as the true method of approach of scientific problems can be well and only well taught with laboratory work. For a woman who is to be a housewife and look after the things of the home, there are very many valuable things that can be taught without laboratory work. She will very likely get to that later in life. Just as one can learn lots about astronomy without a telescope, or lots about evolution without experiments, I believe it true in chemistry.

From the chief of a department of agriculture in a large state university:

At the present time, freshman chemistry for chemists is not taught in the way that a 10-credit course for arts students ought to be taught, in my opinion, for such a course leaves out all reference to organic chemistry or biological chemistry. I would rather take such students up on the top of a mountain and show them of what good chemistry is in this world, rather than give them just one little edge of the field and consider that I had satisfied their registration credits. If you can give them the proper picture of chemistry, you will make friends of most of them. If you do not give them that picture, most of them will hate chemistry the rest of their lives.

I was just talking to a group the other day in regard to this problem; and I insisted that if I were teaching such a course, I would have a separate course number for the lectures and the laboratory and would not require laboratory work to begin until the lecture work was well under way, say, at the end of the first quarter, or perhaps the middle of the first semester, if the semester basis is used, and then allow only those students in the laboratory who have become interested in chemistry through the lectures and who have made sufficiently good grades to justify the time and money which would be spent in the laboratory work. Then, I would make the laboratory work just as interesting as possible, bringing out important factors rather than petty details. I believe that in this way one could get a group of students who would be up on their toes all of the time in their laboratory work, and at the same time eliminate from the laboratory the great mass of students who now take the laboratory simply because they have to,...

In these days of university economy, with the registrations growing and budgets

standing still, I believe in spending the money where it will at least do a little good, and I personally doubt if herding sixteen or seventeen hundred freshmen through three afternoons' work in the laboratory every week for a year, such as is the practice here, and then turning them loose with no possibility that more than twenty per cent of them will ever take any more chemistry, is a justifiable procedure from the standpoint of the expenditure of public funds. In the first place, I don't think they have been taught what they need to know, and I am certain that the results of the laboratory work which they have done are not of sufficient value to justify the enormous expenditure involved.

From the head of the chemistry department of an important university:

If I were attempting to develop such a course, I am quite sure that I should find place for laboratory exercises, but not of the systematic type which we are in the habit of giving to scientific students. It would appear best to introduce exercises which would bring the student in contact with more of the applications of chemistry to daily life so that he would be able to visualize more concretely the matters that are taken up in the classroom. In all events, I should expect to do rather elaborate lecture demonstration.

From a professor of organic chemistry in a large state school:

I believe if such a course is given, it should be given without laboratory. The whole claim of such courses is that they are dealing with students who do not wish to become chemists in any sense of the term, and probably in most cases a good many students do not even have a scientific attitude of mind. I think it will be a mistake to put a large number of such students in a laboratory. In the first place, it would probably be expensive to the institution, and I doubt if more than a few of the students would profit by laboratory work.

I think you will agree with me that this will necessitate a considerable amount of lecture-table experiment demonstration in order to relieve the monotony of continuous lectures or routine recitations. Experiments done on the lecture table are, as a rule, much more successful than individual experiments, and the instructor can emphasize the particular points to be observed and connected up with theory. I also believe that a good deal of such a course should be simply for information. Enough theory must be given to acquaint the students with the fundamental principles, but I believe that aside from this, the only things which the students will get and hold onto will be the striking facts regarding the more common and more interesting substances and the importance of these substances in connection with daily life, both as related to industries and as related to human welfare.

After investigating this question, we have decided that the lecture demonstration is the best plan for a course of this kind. Individual experiments could be used with profit for all students if competent supervision were available, but this is not adequately available, even in the majority of technical courses.

On the other hand, experience has shown that there are always a few students who would profit greatly from an individual laboratory course, even with poor supervision. We, therefore, plan to give such a laboratory course in connection with our regular course in the appreciation of chemistry, for extra credit, making it entirely optional.

Some Practical Points

1. Home Reading References

Few college texts in general chemistry would be read by an intelligent adult who is seeking to add to his knowledge of chemistry. Students are required to use such texts, and yet adults and the young learn in about the same way. Fortunately, an ever-increasing number of writers who have caught the spirit of Dr. Robinson's book, "The Humanizing of Knowledge," are supplying us with books on chemistry which adults are reading. We have chosen these books for use in our course in the new introductory chemistry.

Every student obtains the set of nine books distributed by the Chemical Foundation. These books, along with the educational pamphlets issued by many industries serve as the required reading references.

2. Additional References

In addition to the home reading references, a selected list of about 100 books and numerous pamphlets in addition to the more important chemical periodicals are available for the use of the students in preparing special reports and essays.

3. Teaching Methods

As far as possible the most effective teaching methods are employed, including visual education. The time spent in the class periods is a combination of lectures, special reports by the students, visual instruction, and experiments. The lecture method is used to a large extent for it is best fitted for a survey course of this type. No provision is made for the general recitation; for, as Alexander Silverman has said, "The general recitation seems unnecessary. It is a wasted hour for one who knows his subject."

It has been our experience that short daily quizzes, and long monthly and final examinations are ample not only to determine the progress of the students, but also to insure that they keep up to date in their home readings. Unless the students read the home reading references the course will be a failure; so we strongly advise daily quizzes, unless a better plan is discovered to prod the student to action.

A large number of special reports are assigned to the students; for we have found that this principle of self-activity lends interest to the class work, and stimulates a much wider acquaintance with the sources of material. In order to make the special reports effective, they must be handed in for criticism before they are given to the class.

Where Should the New Introductory Chemistry Be Taught

The course which we have developed is intended to provide the background necessary for a more complete appreciation of the standard courses in chemistry, which it is not designed to replace, but for which it is intended

to be, and in actual use, has proved to be a recruiting agency. It, therefore, properly belongs in the high-school and junior college curricula.

For students who will not take the usual advanced chemistry courses, this course will prove to be most valuable in giving an appreciation of chemistry, as well as many important practical applications that generally come only after several years of chemistry work.

Leonard Koos[2] has shown that the high-school students taking chemistry are predominantly seniors and that the college students are predominantly freshmen. The year's difference is not enough to warrant a very great change in the extent of an appreciation course, so that our course is designed for use in both colleges and high schools with the omission of a few optional topics where time is lacking.

There is room for pandemic chemistry in the college, but its proper place is in the high school, as Dr. Bancroft states. It should be taught in the high school for the following reasons:

1. It is better fitted to the training of the average high-school teacher. Like all courses, the better the training of the teacher, the better the course will be. Such a course will demand the highest ability, but can be given with greater likelihood of success than that achieved in the usual course by the average chemistry teacher in high school.

2. It is better fitted to the facilities of the average high school as to equipment and supplies.

3. It is better fitted to the mind and age of the high-school student.

4. It will popularize chemistry in the high school rather than instigate a dislike for the subject, as the usual course does.

5. It will solve the problem of the correlation of the high-school course with the college general chemistry course.

6. Such a course will be of more lasting benefit than the usual course to the student who will not attend college.

7. It will inspire students to do serious work in chemistry when they enter college.

8. Since there is no place in the regular college curriculum for a course in the appreciation of chemistry of students majoring in chemistry and allied sciences, it must be given in the high school, or not be obtained at all by such students, unless it is by their own initiative.

9. It would do away with the waste of time and energy consumed in learning a mass of technical information which is too difficult for the average high-school student to master intelligently.

Can the Appreciation of Chemistry Be Taught Effectively as a Part of the Usual General Chemistry Course?

Several general chemistry texts have appeared in the last year or two which claim to incorporate Dr. Bancroft's Pandemic Chemistry in their

course. These books are a step in the right direction and Dr. Bancroft has been of great service in stimulating the humanizing of our general chemistry texts.

General chemistry teachers need to be humanized also. Our own experience is that if a teacher tries to give a course in the new type of introductory chemistry, he will be humanized, thus becoming a much better teacher. There is a surprising amount of practical, interesting information in the books available for such a course, which the average chemistry teacher does not have, because his highly specialized course of study has not had room for this type of material. It is true that much of this material comes by experience; but most teachers do not have the opportunities and the means to obtain this experience.

We agree that it is possible to humanize our chemistry texts and teachers, but we agree with Dr. Bancroft that the better general chemistry is as a professional course, the worse it is as a cultural course. The reverse is likewise true. No general chemistry text can serve as the basis for a course in the appreciation of chemistry.

How to Correlate the New Introductory Chemistry with the Advanced Courses in Chemistry

If such a course is given in high school, it will be so different from the usual college chemistry course, that no trouble will be experienced in correlating the two.

In case this course has not been given in high school, the student should be given this appreciation before taking college general chemistry.

Beginning last year, each candidate for the B.A. and B.S. degrees at Baylor College, except those presenting high-school credits in chemistry, was required to take one term of the new introductory chemistry, which covered the material outlined in Book I of the course as outlined below. At the conclusion of this term, those students who were not going to specialize in fields requiring general chemistry were enrolled for a second term of this course, which covered selected portions of Book II. This satisfied the chemistry requirements for graduation. Students who decided to specialize in subjects requiring general chemistry, and those students who caught the vision, were then enrolled for two terms of general chemistry. Students presenting high-school credits in chemistry were exempt from the appreciation course on the specious assumption that they had had the equivalent of such a course in high school.

This plan worked out very acceptably on the term basis. In schools where the semester plan is used all students would be enrolled for a year of chemistry. The first third of the year's work would cover Book I as outlined below. The class would then be divided as indicated above, some students taking general chemistry for the balance of the year, and other

students continuing the survey course, studying the material as outlined in Book II.

There would be some repetition in the usual general chemistry course, but there are textbooks of general chemistry now available which are based on a high-school course containing the minimum requirements, whose use would eliminate such repetition entirely.

Outline of Proposed Course

BOOK I—WHAT CHEMISTRY IS

Assignment Topics

1. Introduction
2. The History of Science
3. The Motives, Characteristics, and Rewards of the Scientist
4. The Pursuit of Knowledge—Belief
5. How Knowledge Develops
6. The Life and Soul of Science
7. The Science Minimum in Education
8. Divisions of Science
9. The Science of Chemistry
10. Chemistry as a Career
11. Matter
12. Energy—The States of Matter
13. Processes—The Kinetic Theory
14. The Classification of Matter
15. Chemical Names and Phrases
16. The Classification of Matter (Continued)—Mixtures
17. The Nature of Colloids
18. The Nature of Solutions
19. Ionization and Electrolysis
20. Applications of the Ionization Theory
21. Chemical Processes—The Atomic Theory
22. The Nature of the Elements of Matter
23. The Structure of the Atom
24. Ancient and Modern Alchemy
25. The Structure of Matter on a Large Scale—Astro-Chemistry
26. The Evolution and Devolution of the Universe—Celestial or Cosmic Chemistry
27. Energy (Thermo-chemistry)—The Atmosphere
28. Energy (Thermo-chemistry)—Oxygen
29. Energy (Thermo-chemistry)—Hydrogen and Water
30. Energy (Thermo-chemistry)—Fuels and Other Sources of Power—Carbon and Its Binary Compounds—Fire Extinguishers
31. Energy (Thermo-chemistry)—Sulfur—Phosphorus—Nitrogen
32. Energy (Thermo-chemistry)—Pyrotechnics—Explosives
33. Organic Chemistry—Hydrocarbons
34. Organic Chemistry—Aliphatic Ternary Compounds
35. Organic Chemistry—Aromatic Compounds
36. The Halogens
37. Methods of Chemistry—Qualitative and Quantitative Analysis

BOOK II—THE RÔLE OF CHEMISTRY IN PROGRESS

Part I—Political Progress

1. Chemistry in Warfare—The Last War
2. Chemistry in Warfare—The Next War

Part II—Hygienic Progress

3. Health and Disease
4. Direct Causes of Disease—The Enemies of Health
5. Direct Causes of Disease—Micro-organisms
6. Health, A State of Preparedness against Disease—The Relation of Food to Health
7. Production of Foods—Fertilizers
8. Classification, Composition, and Functions of Foods—General Survey of the Digestive and Metabolic Processes of the Body
9. Vitamins
10. Vitamins (continued)
11. Minerals
12. Minerals (continued)
13. Carbohydrates—Sugars
14. Carbohydrates—Starches, Dextrins, Gums
15. Carbohydrates—Agar-Agar, Pectin, Cellulose
16. Fats, Oils, and Waxes
17. Proteins—Milk and Milk Products
18. Proteins—Meat, Fish, and Eggs
19. Proteins—Gelatin, Glue, and Leather
20. Food Preservation—Pure Foods
21. Food Accessories
22. The Scientific Preparation of Food
23. Dietary Problems—I. Constipation and Related Diseases
24. Dietary Problems—II. Protein Requirements
25. Dietary Problems—III. Energy Requirements
26. Dietary Problems—IV. Balancing the Diet for Acids and Bases
27. Dietary Problems—V. Balanced Diet
28. Dietary Problems—VI. Corrective Diets
29. Prevention of Disease—Water, Sewage, and Air Purification—Refuse Disposal
30. Prevention of Disease by Destruction, Fumigation, Sterilization, Disinfection, Eradication of Pests
31. Prevention of Disease—Cleanliness, Soaps, Antiseptics
32. Prevention and Treatment of Disease—Immuno-Chemistry—Serum-Therapy
33. Prevention and Treatment of Disease—Glandular Therapy
34. Prevention and Treatment of Disease—Chemo-Therapy
35. Prevention and Treatment of Disease—Chemo-Therapy (continued)—Anesthetics, Poisons, Electro-Therapy, X-Rays
36. Prevention and Treatment of Disease—Chemo-Therapy (continued)—Synthetic Products—How Chemistry Attacks Its Problems in Medicine
37. Prevention and Treatment of Disease—The Chemistry of Disease Diagnosis—The Battle against Insomnia, Tuberculosis, and Dysentery

Part III—Industrial and Economic Progress

38. Chemistry and Communication—Textiles
39. Chemistry and Communication—Paper, Ink, Photography
40. Chemistry and Communication—Rubber

41. Chemistry and Communication—Metals, Iron and Steel, Corrosion, Rust Resisting Metals, Alloys
42. Chemistry and Communication—Metals, Precious and Rare Metals
43. Chemistry and Communication—Synthetic Plastics, Radio, and Incandescent Lamps
44. Chemistry and Transportation—Materials of Construction—Mineralogical and Geological Chemistry
45. Chemistry and Transportation—Materials of Construction (continued)—Ceramic Chemistry
46. Chemistry and Transportation—Materials of Construction (continued)—Abrasives, Aviation, Railroad, Lubrication, Wood, Cork

Part IV—Social and Esthetic Progress

47. Dyes
48. Paints, Varnishes, and Colors
49. Perfumes and Flavors
50. Cosmetics

A CORRECTION

The reference in footnote 6, page 1809, of the article on "The New Introductory Chemistry. Part I," by Bawden in the October issue was erroneously given as **1,** 55–8 (Jan., 1925). The correct reference is **1,** 55–8 (Mar., 1924).

Vitamin D Prevents Rickets by Killing Bacteria. Rickets is fundamentally a bacterial disease, caused by the poisonous products of bacteria in the digestive tract. Vitamin D prevents this distressing ill of childhood primarily by killing off a large proportion of these harmful microörganisms. These claims, differing radically from the concepts now orthodox in physiology, were advanced at the fall meeting of the American Chemical Society at Minneapolis, by Lester Yoder, chemist at the Iowa Experiment Station, Ames.

Mr. Yoder was led to his conclusions by a study of the bacterial population of the intestinal contents before, during, and after the administration of vitamin D. While his experimental animals were receiving the vitamin the bacterial count fell off markedly, but increased again when the vitamin was discontinued. For this reason the Iowa chemist suggests the possibility of using vitamin D as a means for the general control of the bacterial growths within us, as well as for the specific cure or prevention of rickets.

Studies on vitamin D in the test tube as well as on its physiological effects have confirmed Mr. Yoder in his opinion that it exerts its principal effects without ever leaving the digestive tract. Pure ergosterol, which is the stuff that becomes vitamin D when ultra-violet light has shone upon it, is almost insoluble in water, he said. After exposure to ultra-violet radiation it becomes even more insoluble. In this condition it would be extremely difficult, if not impossible, for it to pass through the intestinal wall and be absorbed into the circulating blood. For this reason the experimenter concluded that it exerts its chief influence during its passage through the digestive tube, and not in the circulatory system.—*Science Service*

ABSTRACTS

APPARATUS AND LABORATORY PRACTICE

Simple Extraction Apparatus for Liquids. H. BACH. *Chem.-Ztg.*, **53,** 517 (July 3, 1929).—In Figure 1, *E* is the extraction vessel with the side-tube *R* which is connected with the flask *K* containing the extracting liquid, *e. g.*, ether. The top of the extraction vessel is joined to a reflux cooler. The lower end of the reflux tube *F* ends inside of a funnel *T* which it holds in a vertical position. The liquid to be extracted is placed into the extraction vessel up to about 1 cm. below the side-arm tube *R* and the apparatus is put together as shown in Figure 1. The ether vapor rises through *R* into the upper part of the extraction vessel. After condensing in the cooler the ether flows through the funnel *T* into the liquid and finally returns through *R* to the flask *K* in which the extract is collected. The extraction is a continuous process.

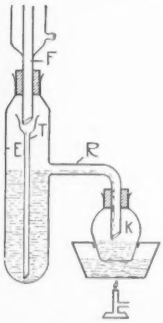


FIGURE 1

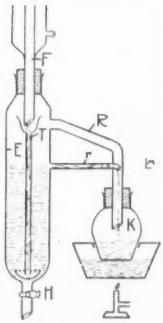


FIGURE 2

Figure 2 shows an apparatus which is still more effective. The tube *R* is placed higher so that the ether vapors reach the reflux cooler more quickly. The ether extract returns through a second tube *r* which is fused through the wider tube *R*. In this way the effect of cooling of the rising vapor by the extract is greatly diminished. The funnel *T* is closed at its lower end but contains a number of openings on its lower wall. When the extraction is finished the remaining liquid is removed through the stopcock *H;* the ether is distilled from *K* into *E* and likewise removed through the same stopcock. The extract remains then in the flask *K*. L. S.

A Little Arrangement for the Cooling of Vessels. WALTHER FORSTMANN. *Chem.-Ztg.*, **53,** 547 (July 13, 1929).—It occurs frequently that heated liquids must be cooled rapidly. If the liquids are inside of cylinders, flasks, test tubes, etc., then they can easily be cooled by letting water run down the walls of the vessel without any danger that the water comes in contact with the liquid. In the case of beakers, evaporating dishes, etc., this method cannot be used efficiently. In such cases the stream of water must come from the bottom.

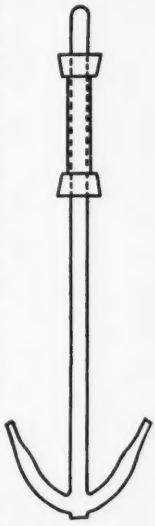
The arrangement is as follows: A piece of glass tubing which is bent upward at a right angle and which has an inside diameter of 10 mm. is attached to wooden blocks (10 × 10 cm.) which are covered with lead to increase the weight and stability. The vessel to be cooled is placed on a tripod or iron ring above the glass tubing which is connected to a water outlet by means of rubber tubing. By this arrangement it is possible to cool quickly a large quantity of liquid. L. S.

Apparatus and Methods for Preparing Very Clean Mercury. D. ROLLER. *J. Optical Soc. Am.*, **18,** 357–9 (April, 1929).—"Any process which proves adequate for the purifying of a metal used as the active substance in a photoelectric cell can also be employed with considerable confidence in other fields of experimentation where extraordinary purity is desired. This follows from the fact that the highest obtainable degree of purity is the most essential requirement in the investigation of the photoelectric properties of a substance.

"The following technic for cleaning mercury for photoelectric purposes has been used by the author with success [*Phys. Rev.*, **32,** 323 (1928)]. (1) Remove grease by washing mercury thoroughly with a 10 per cent solution of potassium hydroxide. (2) Shake or mix the mercury for several hours with an equal volume of 3-normal nitric acid, thus removing most of the metallic contamination. (3) Wash the mercury with distilled water, dry by heating it to about 110°C. in a porcelain dish, and filter by forcing it through chamois skin, or by passing it through a pinhole in the apex of a glazed paper funnel. (4) Distil the mercury several times by the method of Hulett and Minchin [*Phys. Rev.*, **21,** 388 (1905)]; in this method, air is bubbled through the mercury in the still during distillation, thus oxidizing volatile foreign metals. (5) Pass the mercury through a filter consisting of a glass tube with one end drawn to a capillary opening; repeat this process until all traces of oxide have disappeared from the surface of the

mercury. (6) If it is desired to remove occluded gases, as is necessary in photoelectric work, distil the mercury repeatedly in the highest obtainable vacuum. The still used in this process should form an integral part of the apparatus in which the mercury finally is to be used. This method of removing occluded gases from mercury was first used in photoelectric work by Kazda [*Phys. Rev.*, **26**, 643 (1925)].

"The washing processes described in steps (1), (2), and (3) above are best accomplished with a centrifugal mixer (see Figure). This device can be made easily and it is more effective than the 'fall tube' commonly employed in cleaning mercury, or than the ordinary mechanical stirrer; Bray [*J. Am. Chem. Soc.*, **49**, 2572 (1927)] used a centrifugal mixer in preparing mercury, but does not describe it. This mixer is more efficient than the ordinary stirrer and undoubtedly can be put to many uses beside the present one, particularly in the organic chemistry laboratory. The vertical shaft of the mixer consists of a 30 cm. length of 7-mm. glass tubing. The upper end of the shaft is closed and to the lower end is sealed a 10 cm. length of similar tubing, shaped as in the Figure, and drawn out at each end to an opening approximately 2 mm. in diameter. This tube contains a third opening in its lower center, opposite the point where it is sealed to the shaft. The upper end of the shaft is fitted with a piece of short glass tubing of slightly larger diameter than the shaft, this being held in place by two perforated corks which fit the shaft tightly. It is necessary to lubricate the part of the shaft between the two corks with a small amount of vaseline or graphite.



"A clamp is attached to the larger tube, between the corks, and the mixer is supported vertically in a battery jar containing the mercury and washing liquid. The liquid should cover the openings in the ends of the mixer and the shaft should be so adjusted that air and mercury alternately enter the center opening during rotation. It is essential that the mixer be operated at high speed, preferably by means of a small motor attached to the shaft with rubber tubing or with a belt.

"The still used in step (4) of the cleaning process should be constructed in the manner described by Hulett and Minchin, except that all joints made with rubber tubing or stoppers should be replaced by ground glass joints. Experience also shows that a receiving bottle for the distillate, connected to the condensing tube by a ground glass joint, is much more convenient and also less fragile than the usual tube of barometric height.

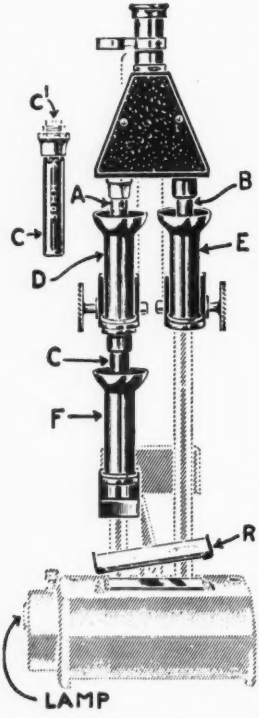
"Since phosphorus pentoxide is often used as a drying agent in apparatus containing mercury, it might be well to state here that the phosphorus and lower oxides, often present in impure phosphorus pentoxide, are likely to soil mercury. Phosphorus pentoxide can be purified sufficiently for this purpose by heating it thoroughly in a current of dry air." R. L. H.

Platinizing Glass and Other Substances. G. F. TAYLOR. *J. Optical Soc. Am.*, **18**, 139–42 (Feb., 1929).—Glass may be platinized with a strong adhering coat of platinum by dissolving absolutely dry $PtCl_4$ in twice its volume of oil of lavender and stirring until no lumps of $PtCl_4$ are left after standing an hour. The glass to be platinized is dipped into the paste and the excess allowed to drain off. At this point two courses may be taken, which depend upon whether the glass is to receive solder or a mirror is to be made. If the glass is to receive a solder, the glass is dipped into the paste and excess allowed to drain off for half a minute. Then the glass is turned in various positions to evenly distribute the paste, while at the same time it may be held in the flame. At a temperature of about 200°C. the glass receives a glossy black coating; at 320°C. a brilliant mirror is formed, while if the glass is heated to the bending temperature a more adhesive coat is formed. The glass can then be soldered as if it were solid Pt.

If a mirror is desired the mass of oil of lavender and $PtCl_4$ is taken up in absolute alcohol and centrifuged. Pale yellow needles separate which may again be washed with absolute alcohol. These crystals are dissolved in oil of lavender in proportions of 25 of oil to 1 of platinum by weight. A chemical reaction takes place between oil of rosemary and $PtCl_4$ which is evidenced by heat. A second similar reaction takes place between the crystals of the Pt compound and oil of lavender. The final product is a Pt compound which is the active product of the solution. All foreign particles must be removed by filtering through a small filter using suction, collecting filtrate in test tube. Test for foreign particles may be made by applying a coat of Pt to a rod and burnishing it with a

coat of cloth. Air holes indicate impurities. The glass to be platinized is then heated in direct flame to dull redness. A thin coating of solution will make a mirror of incomparable brightness. Several materials may be platinized such as glass, dehydrated borax, quartz, mica bone, calcite sapphire, diamond, or any other vitreous material. Platinized glass has several applications. A spiral may be made around a platinized glass rod that makes a neat electrical resistance, for slits in spectroscopes, a grid for a selenium cell, small heating coils, vacuum-tight seals, etc. R. L. H.

A Modified Colorimeter for the Determination of Hydrogen-Ion Concentration. J. J. BEAVER. *J. Optical Soc. Am.*, **18**, 41–9 (Jan., 1929).—The colorimeter methods, which require no standard buffer solution for determination of hydrogen-ion concentration developed in recent years, depend upon a knowledge of the dissociation constant of the indicator. If the indicator dissociates into a weak mono-basic ion, the relationship between dissociation and the hydrogen-ion concentration may be calculated by the equation $pH = pK \log \alpha/1 - \alpha$ where pK is the indicator constant and α its degree of dissociation. Poly-acidic or poly-basic indicators do not follow the simple relationship and no equation can be used to compute the hydrogen-ion concentration from the dissociation. Therefore, for the present, colorimeter determination of hydrogen-ion concentration is limited to a one-color indicator, or a two-color indicator whose dissociation can be calculated by the above equation.



Bjerrum, Michaelis, and Sørensen described a method using a one-color indicator, as nitrophenol, where amount of color is determined. In Gillespie's method known concentration of acid and alkaline form is used, which method requires considerable time. Gillespie suggested a special colorimeter for comparison of colors.

The author employed a Duboscq Type Colorimeter similar in all respects to a standard colorimeter with the addition of an added cup and plunger. In the Figure, *A*, *B*, and *C* are hollow glass plungers with optically plane and parallel ends attached to the instrument by threaded metal adapters. Plungers *A* and *B* screw into the frame of the instrument while *C* screws into the bottom of the holder for cup *D*. This cup holder can be raised or lowered by means of a screw at side of cup. As cup *D* is raised or lowered plunger *C* is also raised or lowered. Cups *D*, *E*, and *F* are of black glass on which are fused bases of clear optical glass. Tops of cups are flared to prevent overflowing. Diameters are such that 10 ml. of liquid gives 52 mm. depth while 5 ml. gives 20 mm. depth of liquid. Cup *F* is adjustable by screw which is usually regulated so that the total depth of liquid between the bottom of plunger *A* and cup *D* plus that between plunger *C* and cup *F* is 50 mm. This is done by setting cup *D* so that the scale reads 50, which shows that the distance between plunger *A* and the bottom of the cup is 50 mm. and then bringing up cup *F* until its base is in contact with the face of plunger *C*. Then, when cup *D* is raised 10 mm., the depth of the liquid between its base and plunger *A* is decreased by 10 mm., while the distance between plunger *C* and base of cup *F* is increased by 10 mm. When amount of unknown is small the instrument can be adjusted for some other depth of liquid by setting cup *D* and raising cup *F* and its holder until stopped by *C*. This design keeps the total depth of liquid constant no matter what this total depth or the ratio of the depths of the liquids in the two cups may be. On the right side of instrument is cup for unknown solution adjustable from 1 to 50 mm., the depth of liquid being equal to total depth on left side of instrument. Since light rays have to pass through more layers of glass on the left side than on the right side, the opal glass *R* is placed in the light path, the tilting of which equalizes the intensities of the light rays. Equalizing intensities is important to accurately match the two half fields. A 25-watt bulb furnishes illumination which passes through a "daylight" filter before passing through the equalizer *R*.

The light illuminates the table which is carried on rollers in the base. The table has values of the ratio $\frac{50 - X}{X}$ from 5 to 45 as well as pK values as determined by this instrument for common indicators. If the unknown is colored it is balanced on the left side of instrument by unscrewing C^1, filling C with unknown and then screwing C into place.

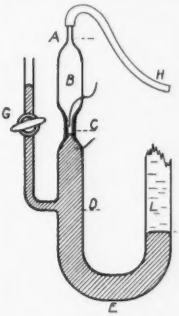
Method.—Buffer solutions of approximately 1 M HAc, 0.05 M KH_2PO_4, 0.05 M Na_2HPO_4, and 0.01 M Na_2CO_3 were used to produce standard colors. To produce acid color of thymol blue 0.1 M HCl was necessary. Then 10 ml. was placed into cups D and F. With cup E set at 50 mm. cup D moves up and down until the two half fields match. Since the acid color of the indicators is in cup D, the reading X on the left scale is the amount of acid in the unknown, while $50 - X$ is the amount of alkaline color, the total depth always being 50 mm. Then from the equation $\text{pH} = \text{pK} + \log \frac{\text{alkaline}}{\text{acid}}$ where $\log \frac{\text{alkaline}}{\text{acid}} = \log \frac{50 - X}{X}$, the pH of the solution can be calculated.

Experimental Results.—Tables are given in original paper showing colorimeter readings for pH values of common indicators and compared with pH values as determined electrolytically, the largest deviation from electrolytic measurements being a pH of 0.023.

Conclusions.—A method which is both rapid and accurate and eliminates standardized buffer solutions in determination of pH of a solution on colorimetric basis.

R. L. H.

Temperature Control Apparatus. L. A. RICHARDS. *J. Optical Soc. Am.*, **18,** 131–7 (Feb., 1929).—A temperature control apparatus for maintaining a temperature below that of the room was made by constructing a chamber 4 × 4 × 7 feet of compo board. The air was cooled by running water through an automobile radiator. An electric fan kept the air circulated. Heating unit of nichrome wire with thermo-regulator was installed to maintain a constant temperature.

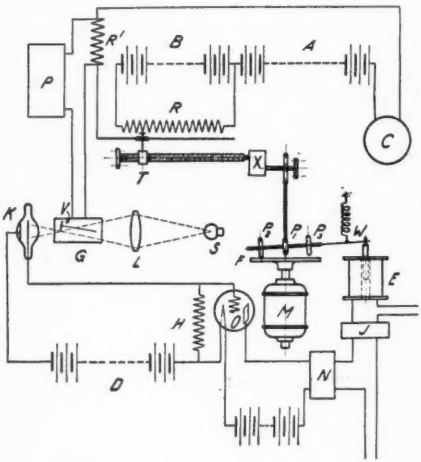


Thermo-Regulator.—The regulator was constructed as shown in the drawing. The materials needed were glass stopcock, a piece of 10 or 12 mm. bore soft glass tubing and about 5 cm. of 26-gage platinum wire. The large tube was drawn out to a capillary at A and left open until regulator was filled. A constriction was made at C about 2 mm. thick and about 5 cm. from D. The large tube before bending was about 200 cm. long. The stopcock was sealed in the side of the tube opposite D. The tube at L was filled with ether or methyl alcohol depending upon temperature desired and then with mercury from F to D. Hydrogen was then introduced into B until the tube B was filled with pure hydrogen. The temperature was regulated by changing the hydrogen pressure. After construction the regulator was hung on a metal screen to permit free circulation of air around it. With this set-up the temperature variation was too small to be observed with a sensitive Beckman thermometer.

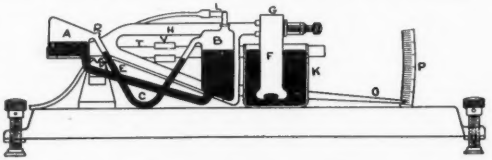
Pencil-type electric heaters were constructed by winding nichrome wire, of a diameter and length to give desired heating capacity, around a porcelain tube which was enclosed in a water-tight tubular brass case. Asbestos sheeting was wound around the terminals to protect them from the case. The heater should be used only under water. A heating current relay was necessary for the indirect regulator. The one made by the General Electric Company was used (Cr 2810–1265). R. L. H.

An Improved Constant Current Regulator. L. G. LONGSWORTH AND D. A. MACINNES. *J. Optical Soc. Am.*, **19,** 50–6 (July, 1929).—A constant current regulator used in determination of transference numbers of ions by moving boundary method which was limited to adjustment of current for variations only in one direction. An additional device described by the authors removed this limitation and adapted the apparatus for general use. The cell through which the constant current is to pass is connected to the leads at point C. Current is furnished by storage cells A, B partly shunted by resistance R, which is provided with screw adjustment for contact T. The current through the cell is measured by drop of potential across constant resistance R' by potentiometer. The galvanometer G used consists of a needle provided with a vane V of aluminum foil. Light S is focused on vane by means of lens L. If not shaded by the vane light passes to

photoelectric cell K which is made conducting, setting up a potential on the grid through element tube O from battery D. The current is thus stopped between the filament and plate, which in turn operates the sensitive relays N and J. This arrangement only operates a constant current in one direction. The following correct for both positive and negative deviations. A small motor continuously turns a circular Bakelite disk F. A shaft holding the grooved pulley P_1 and rubber-tired pulleys P_2 and P_3 is pivoted with bearings above and below the pulley P_1 so that the shaft can swing around an axis at right angles to the axis of disk F and to the shaft itself. The pulley P_1 is connected by a light belt to the reducing gear X which in turn operates the screw adjustment to contact T on rheostat R. The shaft containing P_1, P_2, and P_3 is normally held by a spring W so that pulley P_2 is in contact with the revolving disk T, thus driving T in a forward direction. If the electromagnet E receives current through the operation of relay J, pulley P_3 is brought in contact with F and the motion of contact is reversed. If there is an increase in resistance at cell C the vane of the galvanometer swings so that the light will illuminate the photoelectric cell, thus stopping the current through tube O, the relay, and electromagnet. This permits R to move forward which soon makes correction. If too low resistance occurs at C the vane shuts off illumination, current passes through relays and electromagnet, and T is moved in reverse direction. Thus the vane on the galvanometer hovers around zero point. The accuracy of this arrangement was determined with a silver coulometer and an agreement of 0.01% was obtained. R. L. H.



On Some Vacuum-Recording Gages. K. C. D. HICKMAN. *J. Optical Soc. Am.*, **18**, 305–32 (Apr., 1929).—The intermediate region between U-tube vacuum gage and sensitive electrical devices has never been covered. A vacuum device described in this paper works on the principle of a U-tube balanced on a fulcrum. As the pressure decreases the center of gravity of the mercury tube changes with the shift of mercury causing the tube to turn about the fulcrum as in the case of a lever. A pointer indicates the pressure on a scale graduated so that a cm. movement of the pointer indicates a mm. change in pressure. The apparatus is shown in the accompanying figure. A is closed limb of mercury tube, B the working limb, and C is the connecting tube. The fulcrum and pivot D are split in the middle to allow C to pass. E is a safety tube, F is the plunger fastened to a carriage, G, adjustable along an extension of the cradle H, which houses A and B. The mercury dash pot K is large enough to allow for the changing slope of F during operation. The plunger F dips into the dash pot of mercury K to control the amount that the cradle carrying A and B may tilt. The leading tube L may be of some flexible tube, the walls of which will not collapse under suction. A recording pen may be placed on the end of the pointer and the scale replaced by a chart rotated by a clock. The gage should be accurately leveled on a secure foundation. The range and sensibility are determined by adjusting the plunger and adding the right amount of mercury to the dash pot K. The instrument is calibrated conveniently with the McLeod gage. Much more accurate results were obtained when the mercury was calibrated with *n*-



dibutyl phthalate. This instrument showed almost a linear relationship with the McLeod gage between 9 mm. and 0.05 mm.

Several other modifications were devised, a portable, a pendulum gage, and a leveling gage, all of which work on the same principle. Diagrams accompany descriptions. R. L. H.

A Modified Piram Vacuum Gage. T. DE VRIES. *J. Optical Soc. Am.*, **18**, 333–5 (Apr., 1929).—A modified Piram vacuum gage can be made by assembling four carbon or tungsten bulbs in a Wheatstone bridge arrangement and connecting to the vacuum line those which are in the opposite arm of the bridge. The other two bulbs serve as balancing resistances together with a dial-decade resistance box to balance the bridge. The valve of this resistance is to measure the pressure. This gage like the single bulb Piram can be used at constant current or constant voltage. Instead of the resistance in the decade box the voltage across the galvanometer connection can be used to measure the pressure in the gage. There is optimum voltage at which the largest change of resistance with pressure is obtained with 25 volts across the bridge, a change of pressure from 1 to 0.1 mm. meant a change in balancing resistance of 110 ohms. An unbalancing of one ohm deflected the needle of a Leeds and Northrup student galvanometer four divisions. A pressure change of one part in 4000 can be detected. The lower limit of detectable pressure was in the neighborhood of 0.001 mm. R. L. H.

Rapid Approximate Calculation. R. ATKINSON. *Nature*, **124**, 94 (July 20, 1929).—"For all work in which an error up to 10 per cent in the final result is admissible, the following rough logarithm table provides a means of multiplying and dividing which is appreciably more rapid than direct calculation, and in simple cases does not require pencil and paper.

Log.	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
No.	$5/4$	$\pi/2$	2	$5/2$	π	4	5	2π	8

"With some of the figures, of course, every one who has occasion to use logarithms at all is familiar; that the logarithms of $\pi 2$ and 2π can be obtained from that of π by subtracting or adding 0.3 is also in itself self-evident; nevertheless, it seems worthwhile to point out explicitly how very convenient it is to be absolutely familiar with the whole table. The error in every case is less than 1 per cent, and with a little practice it will be found possible also to estimate very quickly the second place of decimals for any number at all with an error that is usually less than 1. An error of 4 in the second place, corresponding to 10 per cent in the number, should then occur only in the results of fairly complicated calculations.

"An error in the decimal point is much less probable than when working with the slide-rule; the method is in fact very reliable for fixing the position of the decimal point in slide-rule results. Its principal other applications are obviously for estimating whether a theory or an experimental method is roughly suitable for a particular purpose, and for checking the experimental results of students in cases where a numerical slip is suspected." C. E. M.

KEEPING UP WITH CHEMISTRY

The Manufacture of Commercial Anhydrous Aluminum Chloride. A. M. MCAFEE. *Ind. Eng. Chem.*, **21**, 670–3 (July, 1929).—In 1913 anhydrous $AlCl_3$ cost $1.50 per lb. For years its use commercially in many chemical processes was held up by its high cost. At present the Gulf Refining Company is manufacturing 75,000 lb. daily from bauxite ore and chlorine at a cost of less than five cents per pound. It gives some of the troubles encountered in the development of the present process. Ores should be low in Si and Fe as both take on Cl and the iron will appear in the final product. The ore is calcined to remove moisture, mixed with coal and liquid binder, and briquetted. The hydrocarbons are removed by heating to 1500°F., leaving briquets composed of 82% bauxite and 18% carbon. These are placed in the chlorinating furnace, heated to 1000°F. and chlorinated for about 10 hours, the $AlCl_3$ being collected in iron condensers. D. C. L.

A New Contact Sulfuric Acid Process. A. O. JAEGER. *Ind. Eng. Chem.*, **21**, 627–32 (July, 1929).—Traces briefly the development of sulfuric acid manufacture through its various stages. The new developments consist: (1) of an automatically controlled temperature gradient, which is maintained irrespective of fluctuations in flow; (2) the use of non-platinum contact masses, not affected by the gaseous poisons for platinum, and which in their conversion efficiency and durability equal or exceed the best platinum contact masses commercially available; (3) following from (2), the elimination of the costly purification processes, necessary with platinum. The contact masses used by The Selden Co. in their new process "contain as their active ingredients non-

siliceous base-exchange bodies in which vanadium oxide is present in the non-exchangeable nucleus. These contact masses exceed in efficiency the best Pt catalysts in commercial use, have an extraordinary resistance to high temperature, long life, and a complete indifference to gaseous poisons for Pt. Under a standard load the conversion is about 97–98.8%. For the first time it is possible in the U. S. to produce acid of chamber strength by the contact process cheaper than by the chamber process, thus giving the manufacturer greater flexibility by serving a wider field. D. C. L.

The Formation and Decomposition of Ozone. E. H. RIESENFELD. *Z. angew. Chem.*, **42**, 729–34 (July 13, 1929).—A review. L. S.

Beryllium. A. STOCK. *Z. angew. Chem.*, **42**, 637–9 (June 8, 1929).—A review of the history of beryllium, its production, properties, uses, and price. Siemens and Halske are working on a "Beryllium Film." L. S.

Beryllium. M. MERLUB-SOBEL. *Metals & Alloys*, **1**, 69–70 (Aug., 1929).—A brief survey of the isolation of the metal beryllium and indications of uses, alloys, and commercial utilization of the metal in the future. C. E. M.

Work on Beryllium and Alloys. H. W. GILLETT. *Metals & Alloys*, **1**, 71–2 (Aug., 1929).—A review of the field of alloys of beryllium with references to original work. C. E. M.

Nickel-Clad Steel in Use. G. R. GREENSLADE. *Inco*, **9**, 10 (1929).—Containers for high-temperature treatments of lead, salt, cyanide, and caustic baths sooner or later give way to corrosion. It has been found, however, that if a low-carbon steel or iron pot has its outside clad with pure nickel by arc welding, the desired durability is attained.

These Niclad pots have been shown by tests to have a durability ratio of seven to one ever any metal or alloy previously used. Nickel and iron are especially effective for such use since their coefficients of thermal expansion are so slightly different that the elastic properties of the two metals will care for such difference at high temperatures. Their thermal conductivities are also three or more times that of any of the alloys previously used for such purposes. The constancy of each metal's tenacity, ductility, and flexibility is highly valuable in this use. B. C. H.

Molds and Chemical Manufacture. HORACE T. HERRICH AND ORVILLE E. MAY. *Ind. Eng. Chem.*, **21**, 618–21 (July, 1929).—Contains an account of the early history of molds and yeasts, and the modern methods of utilizing them as a substitute for complicated and costly chemical processes. Describes briefly the manufacture of citric and gluconic acids and the production of alcohol. There are references to about 40 original papers. D. C. L.

The New Fertilizers. W. S. LANDIS. *Sci. Mo.*, **29**, 124–31 (Aug., 1929).—A brief history of agriculture and the use of fertilizers is followed by a discussion of the types of fertilizers and the prediction that the future fertilizers will be much more concentrated in the three common plant foods, nitrogen, phosphorus, and potassium, than even past history would lead one to suppose. The older organics of animal or vegetable origin will disappear to still greater extent and will be replaced by newer synthetic salts, mostly of inorganic nature. Many new elements will be added to the list of essential plant foods. The inorganic fertilizer materials showing a tendency to deflocculate soils will be replaced by greatly improved combinations. G. W. S.

Silicate of Soda in Petroleum Refining. ANON. *Silicate P's & Q's*, **9** (Aug., 1929).—A resistant coating, which possesses many desirable properties, has been developed to protect the cracking chambers used in petroleum refining. The materials used are: silicate of soda, white silica foundry sand, short fiber asbestos, and water. Directions for mixing, applying, and curing are given.

The new coating shows a good degree of resistance to sulfuric acid and alkalies, and may be found useful in other industries. H. T. B.

The Progress of Organic Chemistry since 1924. E. LEHMANN. *Z. angew. Chem.*, **42**, 803–7; 820–1 (Aug. 3, Aug. 10, 1929).—A survey. L. S.

Progress of Photography in the Last Ten Years. J. EGGERT AND H. MEDEGER. *Z. angew. Chem.*, **42**, 653–9, 684–7, 700–3 (June 15, 22, and 29, 1929).—A survey. L. S.

The Relation of Organic Chemistry to Biology. G. BARGER. *Nature*, **124**, 234–8 (Aug. 10, 1929).—*Presidential address, Section B, British Association, Cape Town*, July 23. An interesting address showing the service to and the interdependence of organic chemistry and biology from the time of Scheele to the present day. T. B. D.

The History and Present Status of the Physicists' Concept of Light. PAUL R. HEYL. *J. Optical Soc. Am.*, **18**, 183–92 (Mar., 1929).—The author briefly traces the history of man's concept of light from primitive times to the present day. Primitive

man regarded light as a material object separate from its source. Pythagorean philosophers regarded sensation of light as bombardment of material particles emitted by an illuminous body. Aristotle held the theory that light was energy. In 1690 Huygens proposed wave theory of light with idea of ether transmission. At the opening of the 19th century Fresnel accounted for phenomena of diffraction, rectilinear propagation, and that vibrations must be transverse. The undulatory theory held the support of Green, Stokes, and Kelvin. Maxwell introduced the electromagnetic theory of light which correlated light and electricity. The experiments of Michelson and Morley on ether drift introduced the theory of relativity which tended to do away with the concept of the ether. The discovery of X-ray introduced a difficulty in the wave theory due to the fact that finest gratings produced no diffraction but diffraction was produced by crystal grating. Imperfection in theory of statistical distribution of energy led to quantum theory which postulated atoms of energy existing in discrete units of definite magnitude which are called quanta. The nature of a quantum has never been clear. The writer thinks we are no nearer an understanding of the nature of light than were our predecessors a generation before. R. L. H.

From Atom to Stars. A. V. DOUGLAS. *Atlantic Mo.*, **144,** 158–65 (Aug., 1929).—An interesting comparative study showing that distances involving the atoms are as small as those involving the stars are large, that the time-keeping of the atoms and of the stars shows another abyss of a similar kind and that man as a physical body is almost but not quite half way between atom and star. G. W. S.

Wave Mechanics. C. F. HAGENOW. *Sci. Mo.*, **29,** 109–16 (Aug., 1929).—A general discussion of wave mechanics as applied to the Schrödinger theory of atomic structure. One of the chief difficulties of the supposedly firmly established wave theory of light is the photoelectric effect which makes necessary a corpuscular theory in order to provide the energy required. In explanation de Broglie proposed a bold hypothesis to the effect that there is associated with every particle of matter a wave motion such that the relation between the motion of the particle and that of the accompanying wave can be expressed by the equation $uv = c^2$, where u is the velocity of the wave, v the particle velocity, and c the velocity of light *in vacuo*. The application of this theory to the atomic orbits of the Bohr atom gave many of the results that had been obtained by more or less arbitrary assumptions. The theory also explains certain other observations. With the help of this theory of light Schrödinger developed his theory of the atom.
G. W. S.

HISTORICAL AND BIOGRAPHICAL

Eduard Buchner. P. JACOBSON. *Ber.*, **50,** 1528–31 (1917).—An address of Paul Jacobson at the meeting of the German Chemical Society on October 22, 1917, in commemoration of the death of Eduard Buchner. M. W. G.

Eduard Buchner. *Les Prix Nobel en* 1907. P. A. Norstedt & Söner, Stockholm, **1909,** pp. 67–9.—An account of Buchner's early training and accomplishments up to the time of the receipt of the Nobel Prize in 1907. M. W. G.

Karl Auer, Ritter von Welsbach. OBITUARY. *Science*, **70,** 207–8 (Aug. 30, 1929).—The death is announced of Karl Auer, Ritter von Welsbach, the inventor of the incandescent gas light, the electric metal thread lamp, and other important technical advances. He was president of the Auergesellschaft which has large chemical works at Treibach, and member of the Academies of Sciences of Vienna, Berlin, and Stockholm. The *London Times* writes: "Karl von Welsbach, who was seventy years of age, was the son of Aloys Auer, Ritter von Welsbach, for many years head of the state printing works in Vienna, and himself known as an inventor of many devices in printing and paper-making. He studied in Heidelberg under Bunsen, and his researches in the chemistry of rare minerals produced several results of scientific and technical importance. His invention of the incandescent mantle was made in 1885, and five years later the company, the Auergesellschaft, which now has 4000 employees, was formed to manufacture the Welsbach patents. The invention of Karl von Welsbach of the osmium filament lamp followed in 1897, and six years later he invented the ferrocerium compound used in pocket lighters. Many scientific bodies in his own country and abroad conferred their honors upon him, and he himself endowed a number of social and scientific institutions."
C. E. M.

Death of Auer von Welsbach. OBITUARY. *Chem. Age.*, **21,** 131 (Aug. 10, 1929).—The death took place on Monday, at his residence at Welsbach Castle, Carinthia, of Baron Karl Auer von Welsbach, discoverer of the elements neodymium and praseodymium, and inventor of the incandescent gas mantle, the Auer gas lamp, and the osmium lamp.

Auer von Welsbach was born in Vienna in 1858. At the age of 20 he went to Heidelberg, where he worked under Bunsen, concentrating his researches on the chemistry of the rare earths. The discovery of the two elements mentioned above was made in 1885. While he was experimenting with the Bunsen burner, the idea of the incandescent light came to him, but it was not until some years afterward that he was able to bring his mantle to perfection, to revolutionize the gas industry, and to make a fortune for himself.

Gas Mantles.—In the course of his researches on the rare earths, Welsbach had been desirous of obtaining a better effect than that produced by heating his material on a platinum wire, and to this end he immersed cotton in a solution of the metallic salt. He found that, after burning off the organic matter, a replica of the original thread, composed of the oxide of the metal, remained, and that it glowed brightly in the flame. The idea came to him of using a fabric of cotton soaked in a solution of a metallic salt for lighting purposes, and in 1885 he patented his first commercial mantle. The oxides used were lanthana, yttria, and zirconia; but they were so fragile as to be practically useless, while the light they gave was very poor.

In subsequent experiments Welsbach found that thorium oxide, in conjunction with other rare earths, increased the lighting power of the mantle. Later it was found that the purity of the oxides had a remarkable effect on the amount of light, and finally came the discovery that a small quantity of ceria mixed with the thoria gave the mantle a very high power of emitting light. This led to the development of the incandescent mantle industry, and in the year before the war Germany alone was consuming nearly 50,000,000 of them.

The Osmium Lamp.—Great efforts had been made to find a material for the filament of an incandescent lamp which would replace carbon and not require a preliminary heating. Welsbach suggested osmium. In 1897 he brought out the osmium filament lamp, and six years later the ferrocerium compound used in making modern pocket lighters. To the end he was active and scientifically alert. C. E. M.

Georg Kassner. F. SIERP. *Chem.-Ztg.*, **53,** 409–10 (May 25, 1929).—A biography. L. S.

William Küster. P. PFEIFFER. *Z. angew. Chem.*, **42,** 785–7 (July 27, 1929).—A biography. L. S.

Richard Lorenz. W. FRANKEL. *Z. angew. Chem.*, **42,** 801–2 (Aug. 3, 1929).—A biography. L. S.

The Origin of the Word "Gas." E. DARMSTAEDTER. *Chem.-Ztg.*, **53,** 565–6 (July 20, 1929).—The word "gas" was coined by Johann Baptista Van Helmont. In his writings he indicates in several places that he was the first one to use this word; *e. g.*, in *Ortus Medicinae, Amsterodami,* **1652,** p. 86 (*Complexionem atque Mistionum Elementalium Figmentum*) he speaks of *spiritus Sylvester* which is formed during the combustion of coal. Van Helmont had observed that in addition to the ash certain products are formed which cannot be made visible (carbon dioxide and possibly carbon monoxide). He adds: *Hunc Spiritum, incognitum hactenus, novo nomine Gas voco...* In the German addition of 1643 he states that the word "Gas" can be translated with *subtiler Dunst* or *klein Dunst.*

Van Helmont mentions furthermore that the *spiritus Sylvester* or what is the same the Gas Sylvester is present in various substances not as such (*actu*) but condensed to something more corporeal (*spiritus concretus et corporis more coagulatus*). It is also formed by fermentation. As soon as the ferment has entered the juice of grapes, apples, berries, honey, etc., the change begins and thus the gas is formed (*bullire ac fervere incipiunt, unde Gas*). He states also that this gas is formed in the stomach after the consumption of too large a quantity of grapes and may thus cause discomfort and disease. L. S.

The Discovery of the Gas Laws. II. Gay-Lussac's Law. W. S. JAMES. *Sci. Progr.*, **24,** 57–71 (July, 1929); see Abstracts, THIS JOURNAL, **6,** 579 (Mar., 1929).—A discussion is given of the work leading up to the formulation of Gay-Lussac's law and a summary of the subsequent history of the law. A. E. C.

Chemistry in Ancient Persia. E. J. HOLMYARD. *Discovery,* **10,** 265–71 (Aug., 1929).—The systematic use of chemistry as an aid to medicine began, in Europe, with "fitful, strange, and moody" spirit Paracelsus (1493–1541). Medicine and chemistry, however, were closely associated in still earlier times. Conspicuous among several chemist-physicians of Islam was Rhazes, who may be called the Paracelsus of Persia. Abu Bakr Muhammad ibn Zakariyya al-Razi, later in Europe called Rhazes, was born at the ancient town of Ray in 865 A.D. In his early thirties he journeyed to Bagdad. Having been injured by poisonous fumes, treated and cured by a physician, and presented with a bill for 250 pounds, he is stated to have exclaimed, "I perceive that here is the true art

alchemy or gold-making." Forthwith he entered upon his medical training. He r became the director and chief physician of the hospital at Bagdad. In later life became blind due to cataract. He had written a book upon the truth of the possibility transmuting the metals, but could not demonstrate before Governor Mansur who is d to have struck him and caused his blindness. Rhazes died in his native town on tober 26, 925 A.D. He is described as having been of a liberal and generous nature, urteous and affable to every one, and exceedingly kind to the poor, upon whom he stowed bounteous allowances and gratuitous medical attendance. He was continu- y reading, copying, or writing, and no doubt this excessive devotion to study was a ntributory cause of his blindness. J. H. G.

EDUCATIONAL MEASUREMENTS AND DATA

The Frequency-Distribution of Examination Marks. W. N. BOND. *Phil. Mag.*, 1135-9 (June, 1929).—It is shown that the frequency-distribution curves of the rks awarded to candidates in non-competitive examinations should not be of various treme types if it is desired to arrange all of the candidates so as to represent their order merit and relative merit accurately. An optimum form of frequency distribution rve is likely and it is favorable to obtain it as nearly as possible. A comparison of rves obtained in various examinations gives evidence that there is considerable agree- nt as to the desirable form of curve. It is shown that the mean curve deduced from se examinations approximates closely to a curve of simple mathematical form, which s probably more significance than a mere average. A. E. C.

The Number of Students of Chemistry. F. QUINCKE. *Z. angew. Chem.*, **42**, 2-3 (May 18, 1929).—The author attempts to interpret the statistics from various urces concerning the number of students who study chemistry in various German in- tutions and to reconcile the discrepancies in these reports. The following table shows e number of students enrolled in chemistry courses.

	1911		1925		1928	
	No.	%	No.	%	No.	%
emistry—Universities	1524	= 100	3693	= 242	2679	= 176
Technical Schools	1671	= 100	3759	= 225	2497	= 149
Total	3195	= 100	7452	= 233	5176	= 162
harmacy—Universities	954	= 100	1505	= 158	742	= 78
Technical Schools	84	= 100	200	= 231	122	= 195
Total	1038	= 100	1705	= 164	864	= 83
Together	4233	= 100	9157	= 216	6040	= 143

L. S.

THE METHODS AND PHILOSOPHY OF EDUCATION

The Contribution of Science to Education. F. N. FREEMAN. *Sch. & Soc.*, **30**, 7-12 (July 27, 1929).—The author reviews the contributions which science has made education because he feels that educational problems can be solved only through sci- tific experimenting and the gathering of facts. The limitations which, he says, charac- ize educational sciences, are discussed in detail. K. S. H.

Science and Education. WILLIAM D. TAIT. *Sci. Mo.*, **29**, 132-6 (Aug., 1929).— civilization advances poetry necessarily declines. Refinement of expression is nonymous with scientific progress. Science means a more exact knowledge of the rld we meet with day by day. Man's efficiency in meeting his environment is the asure of his civilization, and the records of this advance are to be found in the annals science. A nation whose educational system is founded upon merely individual tainment, where each one thinks he knows something of everything, is doomed in a dern and ultra-modern world. We must have specialists in the various aspects of life. hile this appears to be a merely utilitarian attitude, when looked at from the point of w of service to humanity, it means efficiency, *i. e.*, the capacity of doing the right thing the right time and doing it well. As scientists, applying this to our educational meth- s, we should insist that the common-sense methods, custom, tradition, speculation, perstition, and theory should give way to the scientific method. By experiment we certain how children differ with regard to the various mental processes and in intelli- nce. We find, for example, that those who learn quickly learn best, that the child has t the capacity of forming abstract ideas as the adult—which should persuade us to ve science and mathematics till the university age. G. W. S.

Watchwords in Education. W. E. JOHNSON. *Sch. & Soc.*, **30**, 204 (Aug. 10, 29).—Learning by haphazard experience and experimentation is slow progress and

expensive and should be renounced for guidance, supervision, and a broadened environment which, the author says, are watchwords in education today. K. S. H.

Vocational Problems of the College Student. E. S. BOYER. *Sch. & Soc.*, **30,** 203–4 (Aug. 10, 1929).—In discussing vocational problems the writer divides the students into different groups and deals with the problems relative to the group that go to college. Some decisions as to vocation are made when the students are in grade or high school, but for the most part the majority have little idea of what they want to do and so come to college for the purpose of finding out. Required courses, outside work, social contacts, contact with the faculty, etc., usually have their influence on one's decision.

The student should, during his college course, be given every assistance possible to help him decide upon a definite vocation. K. S. H.

Selection as a Function of American Secondary Education. W. C. RYAN, JR. *Sch. & Soc.*, **29,** 787–93 (June 22, 1929).—The writer feels that a high-school education is not only essential but that American material prosperity is largely dependent upon it. Consequently, if all are to be educated thus far, selection is necessary in order that each individual may have additional opportunities and be able to cope with the environment in which he is placed.

Three steps, considered necessary in the reorganization of secondary education if instruction is to be more or less individualized, are given and each step elaborated upon in detail. Because of the enormous enrolment in secondary schools, the quality of the instruction has been neglected, many persons teaching who have little or no mastery of their subject.

In closing a comparison of European schools and our own is made. K. S. H.

Childhood Prejudices. BRUNO LASKER. *School*, **40,** 849–50 (Aug. 1, 1929).—Environment has a greater influence upon prejudices than does heredity. Too many parents usually want, not that their children shall be unprejudiced but that their children shall share their own prejudices rather than those of other people.

Too many of us have two sets of social ideals: one consciously held before ourselves as the culmination of a philosophy of life; the other held by a subconscious attachment and made evident whenever we are caught unawares by a situation that requires immediate adjustment. Children commonly take their attitudes from the second rather than the first of these ideals. They copy acts rather than words.

Aids in developing open-mindedness and tolerance in children rather than prejudices are: travel, correspondence with foreign children, and a rich assortment of callers in the home.

Teachers of science are especially interested in the statement, "An education for open-mindedness would endeavor to emphasize, in the child's mind, the value of knowledge obtained from observation, reënforced by question and answer as against reliance upon entirely verbal sources of information. Prejudice does not flourish where, from early youth, likes and dislikes are habitually subjected to rational processes."

B. C. H.

PROFESSIONAL

An Avocation for the Teacher. T. E. KAUFFMAN. *High-Sch. Teacher*, **5,** 197 (June, 1929).—An avocation for the teacher might justify itself from two standpoints: (1) that a better teacher will result because of enlarged interests and a renewed spirit created by a pleasure obtained from an avocation and (2) that leisure time will be profitably cared for.

It might be said there are two extremes followed by some teachers, the one, the teacher who gives her entire time to her vocation of teaching, the other, the teacher who teaches just so many hours and then follows the line of least resistance in her leisure hours. Both of these methods should be condemned and the teacher who enjoys her profession and makes an effort to keep abreast with an interesting avocation will more than likely be the well-rounded person.

Several illustrations are given to show that many teachers and administrators are thinking along this line. C. E. M.

Concerning Overlapping of Professional Courses in Teacher-Training Institutions. L. HUNSIKER. *Sch. & Soc.*, **29,** 776–8 (June 15, 1929).—Because duplication of material in various subjects has been a basis for considering professional courses as not being equal in college grade to those of the academic departments, the writer set out to investigate her particular course. By submitting true and false statements to a group of students—keeping an equal number of former students as a control group—results were obtained that indicated a minimum of overlapping that was almost incredible.

To prove or disprove that there is repetition in subject matter should be the aim of those who harbor such ideas. "Teacher-training institutions are not only becoming

colleges but are also pointing the way all higher institutions must follow eventually . . ." K. S. H.

The Philosophy and Organization of Research. B. R. BUCKINGHAM. *Sch. & Soc.*, 29, 755–64 (June 15, 1929).—Research, says Dr. Buckingham, is a method and not a field of knowledge. It has as its object not only truth, but new truth, and the making of a contribution. The philosophy of research—its nature, meaning, place, and relation to life are discussed.

It is the author's belief that every educational institution, from the kindergarten up, should be organized both for research and for teaching. Every teacher should contribute to the knowledge in his particular field and in order to do this he must necessarily be engaged in research. K. S. H.

MISCELLANEOUS

Research Scholarships and Fellowships Supported by Industry. C. J. WEST AND CALLIE HULL. *News Ed., Ind. Eng. Chem.*, **7**, 2 (July 20, 1929).—The list given herewith of research scholarships and fellowships, supported by industrial concerns and trade associations, has been extracted from the second edition of the National Research Council's *Bulletin* on "Fellowships and Scholarships for Graduate Work in Science and Technology," which will be ready for distribution in the fall. This *Bulletin* will contain full details regarding the awards. C. E. M.

Accredited Higher Institutions. *Educ. Record*, **10**, 132–49 (Apr., 1929).—In 1924 the American Council of Education approved and published two reports of its Committee on Standards, recommending uniform standards as criteria for accrediting colleges, teacher-training institutions, and junior colleges. Since then the various regional associations have worked continuously on this problem, have revised their respective lists each year, and are gradually working toward uniform standards. Therefore, the list of accredited higher institutions published by the Council in 1928 is incomplete.

The list given herewith is merely a compilation as of April 1, 1929, of the lists of the established accrediting agencies: namely, the Association of American Universities, the Association of Colleges and Preparatory Schools of the Middle States and Maryland, the Association of Colleges and Secondary Schools of the Southern States, the North Central Association of Colleges and Secondary Schools, and the Northwest Association of Secondary and Higher Schools.

It will be noted that the four regional associations of colleges and secondary schools just mentioned cover among them the entire United States with the exception of New England and the far Southwest. Hence institutions in those two regions would not appear in the following list unless they appear on the list of the Association of American Universities, which is a national list.

The American Council on Education has printed as a separate pamphlet its recommendations concerning standards for accrediting higher institutions. Copies of this pamphlet and of the accompanying list will be sent without charge on request addressed to the office of the Council, Washington, D. C. C. E. M.

Bibliography of Czechoslovak Chemical Publications. *Collection of Czechoslovak Chemical Communications*, **1**, 188–201; 411–6 (1929).—This bibliography comprises books and papers in pure and applied chemistry written either by Czechoslovak scientists or originated in Czechoslovak scientific laboratories beginning with the year 1928. Of the general surveys and lectures only those are mentioned which are based on original researches of the author or are distinguished by a novel conception of the subject. The titles of the publications written in Czech are translated generally into the language which was chosen by the author for the summary of the paper. C. E. M.

Death Valley Snow Flakes. Lots of the imitation snow flakes that decorate shop windows during the holidays come from Death Valley.

Boric acid crystals make beautiful sparkling "snow," and have the merit of being non-inflammable. The Pacific Coast Borax Company puts up a brand of "20 Mule Team" crystals called "spangles," and, beside this use, they are excellent for dancing, giving any floor a glass-like surface.

These snowflakes, in cartons, from one of the hottest places on earth, show what can be done in the imaginative marketing of a staple product. For they are another form of borax.—*Chem. & You*, **6**, 4 (1929).

Local Activities

Purpose and Organization

The purpose of the Local Activities Section of the JOURNAL OF CHEMICAL EDUCATION is l
but clearly stated in its title. Any items of local news from institutions, A. C. S. Sections, Tea
Associations, or other organizations which are of such a nature as to make them of more than p
local interest rightfully belong to this Section.

The responsibility of reporting items for this section rests entirely with the local institution
organizations. It is desirable to have a representative appointed to report news regularly. Su
material sent to the editorial office before the 20th of each month will be published in the follo
month's journal. The Editorial Staff must necessarily reserve the right to abridge or totally r
any items submitted. If the following suggestions are followed, however, the necessity for such a
will be largely obviated.

Material to Be Reported

1. Notices of local scholarships or fellowships and announcements of new or unusual courses in c
cal education or special fields of chemistry.
2. Reports of dedication of new science buildings, stressing the unique features.
3. News notes concerning activities of prominent scientists and educators and of the honor
awards made to them.
4. Promotions within, or changes of, personnel of a department.
5. Notices of any special gifts to chemical organizations or departments—as fellowships, endowm
laboratory gifts, library gifts, etc.
6. Accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which mig
suggestive to other organizations. Where original or unusual features are included, it is des
that they be described in some detail.
7. Any subscriber to the JOURNAL, desiring new teaching position or seeking eligible candidat
teaching vacancy, is entitled to two free announcements yearly in this column.

The Pennsylvania State College. DR. WILLIAM J. SWEENEY has resigned as Director of Industrial Research to engage in process development work with the Standard Development Corporation at Baton Rouge, La. Dr. Sweeney received the D.Sc. degree at Massachusetts Institute of Technology last year.

DR. DONALD S. CRYDER has completed his work at Massachusetts Institute of Technology and will resume his duties in the department of chemical engineering at Penn State. His thesis, "The Catalytic Synthesis of Methanol," was carried out under the direction of Professor P. K. Frolich.

A number of new research fellowships amounting to $16,000 per year have been established. This work will be under the direction of DR. FRANK WHITMORE, recently appointed Dean of the School of Chemistry and Physics.

Two new instructors, DR. JOHN G. ASTON, formerly of Northwestern and Harvard Universities, and DR. R. V. MCGREW, formerly of Harvard University, have recently been appointed.

The following graduate students, formerly at Northwestern University, received appointments at Penn State the coming year: HENRY S. ROTH University of Indiana and Purdue U versity; H. M. WOODBURN, Univer of Buffalo; F. E. WILLIAMS, Fran and Marshall and University of Cin nati; PAUL A. KRUEGER, George W ington and South Dakota Universi WILLIAM EVKOVITCH, University of ron; M. A. THORPE, College of Will and Mary; D. J. MCQUEEN, J. PICKENS, and M. S. LARRISON, all the University of West Virginia.

The new unit of the Pond Laborat will be completed early in the fall. Qu titative analysis, organic chemis physical chemistry, microscopy, and departmental library will be housed this building.

DR. GERALD L. WENDT, formerly P of the School of Chemistry and Phys is now assistant to the President, enga in the promotion of scientific rese in the college. One of the import duties of Dr. Wendt is the administra of the $50,000 fund for petroleum search recently appropriated by

State Legislature. The chemical and chemical engineering aspects of the work will be under the immediate direction of DR. M. R. FENSKE, formerly of the Laboratory of Applied Chemistry of the Massachusetts Institute of Technology.

Western Reserve University. MR. V. RICHARD DAMERELL, who has recently received his Ph.D. at the University of Washington, Seattle, has been appointed instructor in chemistry at Western Reserve University, Cleveland, Ohio.

University of Nevada. On the evening of May 1, 1929, DR. W. A. NOYES, SR., of the University of Illinois, presented an illustrated lecture entitled "America's Opportunity in Chemistry." Dr. Noyes spoke also at a luncheon on "International Relations among Chemists."

DR. WILLIAM M. HOSKINS, who, during 1928–29, was absent on leave from the University of Nevada as visiting professor at the University of California, has accepted a position in the latter institution.

DR. RAYMOND D. COOL, who filled Dr. Hoskins' place during 1928–29, has been elected to the staff of the chemistry department of the University of Oregon. He assumes his new duties in the autumn of 1929.

DR. MERYL W. DEMING, who received his doctorate in June, 1928, at the University of Washington, has been appointed instructor in chemistry at the University of Nevada.

MR. FRANCIS S. OAKBERG, A.B., Illinois College, 1929, has been appointed Fellow in Chemistry for 1929–30.

Construction of the new Mackay Science Building has commenced. This building, the gift of Mr. Clarence H. Mackay, will house the departments of chemistry, physics, and mathematics and its completion will furnish facilities for adequate handling of undergraduate and graduate courses in all phases of chemistry. Besides ample room for regular laboratory work, individual smaller rooms and offices will be available for the use of graduate students.

The territorial domain of the Sacramento Section of the A. C. S. has been extended to include Western Nevada and those members of the A. C. S. living in this region are now affiliated with the Sacramento Section. In view of this arrangement, the September meeting of the Section will be held each year in Reno; the program for this meeting is to be furnished by the Nevada chemists and the members from California will journey to Reno to attend. In turn, for subsequent meetings, the Nevada members will cross the Sierras to Sacramento.

DRS. MAXWELL ADAMS and GEORGE W. SEARS, Vice President and head of the chemistry department, respectively, attended the thirteenth annual meeting of the Pacific Division of the American Association for the Advancement of Science, held at Berkeley, California, June 19 to 22, 1929. Dr. Sears served as chairman of the executive committee of the Pacific Intersectional Meeting of the American Chemical Society. At the meetings of this society Dr. Sears presented a paper entitled, "The Behavior of Titanium and Iron during the Pyrosulfate Fusion of Their Oxides."

Colgate University. According to a recent issue of *Science*, after a service of forty-five years as professor of chemistry and head of the department of chemistry at Colgate University, DR. JOSEPH MCGREGORY has resigned and has been appointed professor emeritus of chemistry. DR. R. CHESTER ROBERTS, who has been acting head of the department during the past year, has been appointed head of the department. DR. RAYMOND J. HEMPHILL has resigned as assistant professor of chemistry and has accepted a research appointment at the Pittsfield plant of the General Electric Company. DR. KENNETH H. GOODE, research chemist for the Sylvania Prod-

ucts Company, of Emporium, Pennsylvania, has been appointed assistant professor of chemistry and DR. PAUL B. GLEASON, assistant professor of physics.

William H. Welch Library, The Johns Hopkins University. The dedication of the William H. Welch Medical Library and the Department of the History of Medicine of The Johns Hopkins University took place on Thursday, October 17th. The library was dedicated by PRESIDENT JOSEPH S. AMES, following which an address was made by PROFESSOR HARVEY CUSHING, of Harvard University. The inauguration of the Department of the History of Medicine by PROFESSOR WILLIAM H. WELCH took place on the following day when PROFESSOR KARL SUDHOFF, of the University of Leipzig, made the address.

Mellon Institute, Technochemical Lectures 1929–30. According to a recent issue of the *News Edition* of *Industrial and Engineering Chemistry*, two series of lectures on important subjects in industrial chemistry and chemical engineering will be presented by technologic specialists of Mellon Institute of Industrial Research during the university year 1929–30. These discourses, which will be delivered on Mondays, in the third period (10.30 A.M. to 11.30 A.M.), throughout both semesters, in the Fellows' Room of the Institute, will be open to all students of industrial chemistry and chemical engineering in the University of Pittsburgh, as well as to all the Institute's members. They will also be open, on special permission, to other qualified students of the University and to chemists and teachers of chemistry of the Pittsburgh district.

INTRODUCTORY LECTURE

September 30, 1929, EDWARD R. WEIDLEIN, "Chemical Engineering, the Directional Force of Chemical Industry."

LECTURES ON SOME IMPORTANT CHEMICAL ENGINEERING MATERIALS, THEIR MANUFACTURE, PROPERTIES, USES, AND EVALUATION

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October 7th, R. F. FERGUSON, "The Manufacture of Refractories."
October 14th, S. M. PHELPS, "The Properties of Refractories."
October 21st, S. M. PHELPS, "The Uses of Refractories."
October 28th, C. H. GEISTER, "The Manufacture of Lime."
November 4th, C. H. GEISTER, "The Properties and Uses of Lime."
November 18th, TRACY BARTHOLOMEW, "The Manufacture of Portland Cement."
November 25th, TRACY BARTHOLOMEW, "The Properties and Uses of Portland Cement."
December 2nd, HENRI MARC, "Asbestos and Magnesia Products."
December 9th, R. H. HEILMAN, "Heat Insulation Materials."
December 16th, B. A. RICE, "Vitreous Enamels."

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January 6th, J. D. ALLEY, "Iron."
January 13th, S. A. BRALEY, "Steel."
January 20th, B. B. WESCOTT, "Special Corrosion-Resistant Alloys."

LECTURES ON PROFESSIONAL OPPORTUNITIES IN VARIOUS INDUSTRIES

Inspirational talks on what the chemist and chemical engineer have done, are doing, and can probably accomplish in these fields.

February 10th, H. H. MEYERS, "Fertilizers."
February 17th, E. J. CASSELMAN, "Class."
February 24th, O. O. MALLEIS, "By-Product Coke."
March 3rd, E. W. REID, "Olefine Products."
March 10th, W. B. BURNETT, "Naval Stores."
March 17th, P. B. DAVIDSON, "Paper."
March 24th, H. E. FOOTE, "Industrial Alcohol."

March 31st, R. N. WENZEL, "Fatty Oils and Soaps."
April 7th, G. S. HIERS, "Dyes."
April 14th, C. F. GOLDTHWAIT, "Textiles."
April 28th, H. K. SALZBERG, "Paints."
May 5th, W. W. DUECKER, "Confectionery."
May 12th, G. D. BEAL, "Fine Chemicals."

Scientific Research on Bricklaying at Mellon Institute. An interesting example of collaboration between scientist and artisan is found in the broad scientific study of bricklaying recently inaugurated by Mellon Institute of Industrial Research and the Eastern Face Brick Manufacturers' Association. The experiments are being carried out by DR. F. O. ANDEREGG, Senior Industrial Fellow of the Institute's Multiple Industrial Fellowship on Portland Cement, and his assistants. Architects, building contractors, and masons are aiding the work by contributing opinions and advice based upon experience.

In brief, the investigation will cover certain aspects of all the factors involved in bricklaying. The most obvious points of attack are studies of the characteristics of different kinds of brick and mortar. Problems of special appeal to the practical man are those concerned with different methods of backing and with difference in workmanship. The design of walls and their relative elasticity are subjects which will be of considerable interest to contractors and architects.

Brick and mortar problems under investigation include the absorption and surface characteristics of brick, and differences in mortars due to varying the cementing materials, sand, and pigments. Properties of the mortars which are being studied carefully are workability, compressive and transverse strength, absorption and permeability, shrinkage, durability, staining and efflorescence, and elasticity. Information is being collected to determine whether the 10 per cent of lime often specified by architects or the 25 per cent or more usually employed by brick masons gives better all-around results.

The problems in backing include a study of hollow tile of different sizes, of brick, of cinder or concrete block, of brick tile, and of metal or other lath on steel frame. Variations in workmanship are most apparent in regard to tapping, pointing, and the filling of head-joints. The first-mentioned subject is being studied, not only in regard to the effect of excessive downward tapping into place, but also in regard to plumbing both before and after initial set.

Among the most important problems of design are the nature of the backing unit and the method of connecting the face and backing. Coping and parapet construction are likewise being investigated. Capillary contact with the ground and condensation allow moisture to penetrate into the wall and must be guarded against. Finally, a study of special interest in this day of high buildings is the elasticity of walls of different types.

Special mention should be made of weather problems. The experiments have been planned for the purpose of investigating the behavior of mortar with reference to the other variables in all types of climatic conditions.

All results of this investigation will be published for the benefit of every one interested in building construction.

Sioux Valley Chemists' Club. A group of twenty-five chemists and teachers of chemistry from Sioux City, Iowa, and the surrounding territory in Iowa, Nebraska, and South Dakota, have organized a club known as the Sioux Valley Chemists' Club. It will be the policy of the club to include in each program some things of interest to high-school teachers of chemistry, and in this way the club hopes to be of material aid and assistance to high-school teachers and at the same time give them a reason for taking an interest in the club. The club expects to hold about four meetings during the year of 1929–30 at various places in the three states represented. The secretary of the club is Kenneth C.

Beeson, State Chemical Laboratory, Vermilion, South Dakota.

University of Maryland. The department of chemistry recently announced that the advanced courses, which have been given on Tuesday and Thursday evenings in Baltimore for the past three years, will again be offered at the same time, beginning Thursday, October the first. The course offered for the fall semester will be advanced organic chemistry. Though the course offered is of graduate credit grade, it is open to any student having the necessary prerequisites who desires an opportunity for advanced study.

College of the City of New York. DR. LEO LEHRMAN published an article on "The Fatty Acids Associated with Rice Starch" in the July issue of the *Journal of the American Chemical Society*.

PROFESSOR HARROW, in conjunction with DR. FUNK, presented a paper on hormones before the International Congress of Physiology in Boston, in August.

PROFESSOR BABOR'S book, "General College Chemistry," as well as his "Laboratory Outlines of General Chemistry" (in conjunction with DR. ALEXANDER LEHRMAN), is now off the press. (A review of this book will appear shortly in THIS JOURNAL.)

West Virginia University, D. A. Burt Fellowships in Chemistry. MR. D. A. BURT, Wheeling, West Virginia, member of the Board of Governors of West Virginia University, has given money for the establishment of five fellowships in chemistry, valued at $500 each, at the West Virginia University. These fellowships have been arranged and the recipients who are now at work are: MARY BERNICE BARNETT, A.B., West Virginia University (1929); MAXINE ELLIOTT CRANE, A.B., West Virginia University (1926); JOHN WILLIAM HAUGHT, B.S., West Virginia Wesleyan University (1927); JOSEPH LINDELL KEENER, JR., A.B., West Virginia University (1928); WILLIAM ARTHUR WELCH, A.B., West Virginia University (1928).

Bucknell University. FRANCIS MEEKER, '30, and KENNETH B. ANDRUS, '31, have been awarded valuable scholarships according to an announcement made during the past summer by Dr. John Olsen, chairman of the committee of the Chemists Club of New York City. Both students are registered for the degree of B.S. in Chemical Engineering, and have maintained a high academic record since their entrance to Bucknell.

Meeker has been awarded the Hoffman Scholarship, while Andrus received the Bloede Scholarship. Both scholarships were created by an endowment of $2[illegible] to the Chemists Club in 1916, and are to be granted to students of recognized ability in the field of industrial or engineering chemistry, who are regularly matriculated in some recognized college or university.

As only one of each of these scholarships is granted each year in the United States, it is a singular mark of distinction to thus be chosen as the recipient of either of these scholarships. No obligations are attendant to the grant. The monetary value of the Hoffman Scholarship is $400 while that of the Bloede is $[illegible].

During his first year at Bucknell, the record of Andrus was such as to attain him recognition in the form of the Sigma Beta Chi chemical award. Meeker transferred to Bucknell from Ohio Northern University at the completion of his freshman year, and is very active in chemical investigation work. He is president of Sigma Beta Chi, professional chemical fraternity, for the coming year. Andrus is also a member of Sigma Beta Chi fraternity.

MR. FRANK A. GRUBB, of Oxford, Pennsylvania, was awarded the Sigma Beta Chi prize at the regular commencement exercises last June. This prize is given each year to the freshman chemical engineering student who attains the high

est standing in his chemical studies for that year, consists of an appropriately engraved gold medal. The Sigma Beta Chi fraternity is the local chemical professional fraternity at Bucknell and is responsible for many interesting programs of meetings of professional interest held during the year.

DR. S. C. OGBURN, JR., head of the department of chemical engineering, has recently announced the successful production of aluminum from alunite, and is at present engaged in the small scale operation of the process before publication of the work. During the past year he has been aided in this work by several graduate students: P. L. PATTON, J. R. WEBER, and H. B. STERE. The National Academy of Sciences, through the Bache Fund, has materially aided Dr. Ogburn in the purchase of special equipment used in this work.

University of Florida. DR. T. R. LEIGH, who is head of the department of chemistry, as well as Dean of the College of Pharmacy, attended the meeting of the American Association of Colleges of Pharmacy and the American Pharmaceutical Association held at Cedar Rapids, South Dakota, during the week of August 26th. He gave a paper before the Teachers' Conference on "Methods of Teaching Physiological Chemistry" and one before the General Conference on "Curricula for Colleges of Pharmacy." He is chairman of the committee on "Curricula and Teaching Methods."

The University Summer School, June 10th–August 3rd, closed with record enrolment of both undergraduate and graduate students. Courses in chemistry were given by DR. W. H. BEISLER, who served as acting head of the department, and DR. V. T. JACKSON.

PROFESSOR A. P. BLACK continued to head the work in General Natural Science, which was begun last summer, and also served for the third summer as Dean of Men.

DR. F. H. HEATH devoted the summer to research work.

DR. R. C. GOODWIN spent the first part of the summer in the Chemical Warfare School, Edgewood Arsenal, Md. He spent the latter part in Texas, and attended the Minneapolis meeting of the A. C. S. before returning to the university.

CURATOR B. J. OTTE spent his vacation in Minnesota, returning by way of Minneapolis for the A. C. S. meeting.

MR. G. H. BARBER has been added to the staff as assistant curator.

University fellows in chemistry for the year are: SILAS N. THRONSON, A.B., Saint Olaf's College (1927); one year at Massachusetts Institute of Technology; one year at the University of Wisconsin. HARRY C. WINTER, A.B., University of Alabama (1929). W. E. BLACKBURN, A.B., Georgetown College (1929). LLOYD E. WEST, A.B., Doane College (1928). ARNOLD W. DEAN, B.S., University of Florida (1929). FRED D. AYRES, B.S., University of Florida (1929). G. A. HAWKINS, B.S.E., University of Florida (1929). WOODSON C. TUCKER, B.S., University of Florida (1929).

Wesleyan University. MR. RAYMOND L. JOHNSON, '29, has been appointed State Water Commission Fellow and will continue with Professor C. R. Hoover in studying the satisfactory disposal of industrial wastes and its relation to stream pollution in Connecticut.

MR. LOUIS MINSK, '29, has been appointed to the Rogers and Hubbard Fellowship. He will collaborate with Professor G. Albert Hill in a study of the utilization of tobacco stalks.

T. DONATUS VON MIKUSCH-BUCHBERG is taking advanced work in chemistry while visiting the United States as a student sent by the American-German Student Exchange, operating under the auspices of the Institute for International Education.

ASSISTANT PROFESSOR T. E. CAVELTI received his Ph.D. degree from Yale University in June. He has been promoted to an associate professorship.

University of Pittsburgh. PROFESSOR ALEXANDER SILVERMAN, head of the department of chemistry of the University of Pittsburgh, addressed the St. Louis Section of the American Chemical Society on Monday evening, October 7th, on "Recent Developments in Glass Manufacture." The lecture was illustrated with colored slides showing the progress that has been made in the manufacture of glass.

The following have been added to the chemistry faculty of the University of Pittsburgh for the college year 1929–30: NICHOLAS DIETZ, JR., A.B., A.M., Columbia University. MARTIN E. MCGREAL, B.S., University of New Hampshire; Sc.M., Ph.D., New York University. EDWARD F. FURTSCH, B.S., M.S., University of Michigan. HAROLD D. LEBERMAN, B.S., Allegheny. WALTER W. BRAUN, B.A., University of South Dakota. DAVID GLICK, B.S., University of Pittsburgh. CARL H. RASCH, B.S., University of Buffalo; M.S., University of Pittsburgh. HENRY SEAMAN, B.S., M.S., Carnegie Institute of Technology. BENJAMIN F. STIMMEL, A.B., Bethany. CARL A. WARDNER, B.S., University of North Dakota. WILLIAM A. WAUGH, B.S., University of Pittsburgh. D. W. WEAVER, JR., B.S., Randolph Macon; M.S., University of Delaware. E. GURNEY WHITE, B.S., Vanderbilt University. GUY H. WHITE, JR., B.S., M.S., University of South Carolina.

The following post-doctorate fellows have been appointed: HANS DU MONT, Ph.D., Greifswald; Exchange Fellow of the German University Student Exchange. CHI FANG LAI, Chemical Engineer, National Institute of Technology, Peking, China; M.S., Iowa State College; Ph.D., University of Pittsburgh.

Rutgers University. MESSRS. J. D. NEUSS, G. BLISS, W. MCCONLOGUE, and C. W. MELL have joined the staff of the chemistry department as graduate assistants. Mr. Mell has the degrees of B.S. and M.S. from Connecticut Agricultural College. The other men are alumni of Rutgers.

PROFESSOR I. D. GARARD, head of the chemistry department of New Jersey College for Women, is also on the staff of *Physical Culture Magazine* as an expert in the chemistry of food and nutrition.

PROFESSOR P. A. VAN DER MEULEN spent a large part of the summer doing research work for the Japanese Beetle Laboratory at Moorestown, New Jersey. The Japanese Beetle Laboratory is a cooperative enterprise of the United States Department of Agriculture, and of Pennsylvania and New Jersey. It is organized to combat the Japanese beetle which has done considerable damage to crops since its introduction several years ago.

Iowa State College

DEGREES

The following degrees were awarded at the close of the 1929 summer session: J. D. ROBINSON, Ph.D., organic chemistry. HELEN WOODWARD, M.S., physiological chemistry. J. A. LEERMAKERS, M.S., organic chemistry. C. E. HEADINGTON, M.S., inorganic chemistry. HAROLD JONES, M.S., organic chemistry. R. L. VANPEURSEM, M.S., inorganic chemistry. MARY HELEN MCKENNA, M.S., organic chemistry.

STAFF

New appointments to the staff for the fall quarter are as follows: JEROME ANDES, FLORENCE BARR, HOWARD BENNINGHOFF, W. G. BICKFORD, GLEN BYWATER, EDWARD L. CARR, EUNICE CHAMBERLIN, RAYMOND FRANZ, LOUIS GERBER, ARTHUR HELLWIG, E. L. HENDERSON, RALPH MENZEL, PHARIS MILLER, PERRY MOORE, W. A. PENNINGTON, NELSON SANBORN, PAUL R. VANESS, A. W. WALDE, MARION J. WESTON, P. D. WILKINSON, GEORGE WRIGHT.

PERSONALS

DR. S. D. SATWALEKAR has returned to his home in Bombay, India. R. L. VAN

PEURSEM is now located in Sheldon, Iowa, where he has a position as head of the department of chemistry at the Sheldon Junior College. C. E. HEADINGTON has accepted a position with the Atlantic Refining Company at Philadelphia. J. A. LEERMAKERS is now taking graduate work at the California Institute of Technology at Pasadena. H. L. JONES is now connected with the du Pont Company at Wilmington, Delaware. A. J. HAMMER has accepted a teaching position in the Webster City Junior College, Webster City, Iowa. EDGAR LINEKEN has accepted a teaching position at the University of Vermont. ROMA ELMER is now located in Washington, D. C., where she has a position in the United States Department of Animal Husbandry. B. ROY DANIEL is now residing in Enid, Oklahoma, where he has a position as principal of the Amerson Junior High School. DR. J. D. ROBINSON has accepted a position with the firm of Rohm and Haas at Philadelphia, Pennsylvania.

Numerous ex-students of Iowa State College were visitors on the campus this summer. Among them were: DR. and MRS. C. E. ADAMS (Dr. Adams, '25, is now Research Chemist for the Standard Oil Company of Indiana); MR. and MRS. L. C. HECKERT (Mr. Heckert has a position with the Rohm and Haas Company of Philadelphia); M. P. GRAY, of the Industrial Furnace Corporation, Buffalo, New York; B. L. JOHNSON, '25, now of the University of Montana; V. G. HELLER, '24, now connected with the Oklahoma A. and M. at Stillwater; R. B. WAITE, '26, formerly connected with Texas A. and M., now with the Texas Company at Port Arthur, Texas; MIKKEL FRANKERT, now of the United States Bureau of Standards at Washington, D. C.; LEONA MARSH, now with the S. S. Bowser Company at Fort Wayne, Indiana; L. M. HURT, now affiliated with the University of California; J. A. BURROWS, now located in Stillwater, Oklahoma, where he has a position at the A. and M. College; HELENA MAHNKE HUNT, now of the University of Illinois at Urbana.

University of Cincinnati. The following graduate students have received fellowships and scholarships in the Department of Chemical Engineering at the University of Cincinnati for the academic year 1929-30: TOM BELLIS, B.Sc., Southwest Missouri Teachers' College, Cape Girardeau, Mo. MARY THELMA CROUCH, B.Sc., Converse College, Spartanburg, S. C., MELBURN HEINIG, Ch.E., Rose Polytechnic Institute, Terre Haute, Ind. VICTOR M. HOVEY, B.Sc., Penn College, Oskaloosa, Iowa. HOOPER LINFORD, M.S., Washington State College, Pullman, Washington. JOHN P. MARTIN, B.Sc. in Ch.E., University of Iowa, Iowa City, Ia. KENNETH MILSTEAD, B.Sc., Kirksville State Teachers' College, Kirksville, Mo. ROLAND E. PARRISH, B.Sc. *cum laude*, American University, Washington, D. C. HOKE S. GREENE, M.Sc., NELSON F. MURPHY, Ch.E., J. WAIDE PRICE, M.A., OCTAVIA SPENCER, B.Sc., MINNIE VANVALKENBURGH, M.A., all of the University of Cincinnati, Cincinnati, Ohio.

Dickinson College. HORACE E. ROGERS, who has been at Princeton during the past two years, has been appointed associate professor of chemistry at Dickinson College.

University of Dayton. DR. M. E. HAAS, after a three years' leave of absence spent largely at the Bureau of Mines Laboratory in Pittsburgh, has returned to his post here, assuming his duties in connection with the chair of physical chemistry.

The department has received from one of its alumni, MR. VICTOR EMANUEL, of New York City, the gift of a complete file of Liebig's *"Annalen der Chemie,"* beginning with 1832 and brought down to date. This set was the only available one in the original obtainable in the European market.

Greeley High School, Greeley, Colorado. According to the *Greeley Daily Tribune*, popular science classes started this season with the first meeting of the year on Friday evening, September 12th, at the Greeley high-school chemistry laboratory, at 7.30. FRANK S. HANNEN, as in previous two years, will be in charge.

"The Pontine Ray in Relation to Health" was the subject of the meeting. The subject matter of how a light ray, or a ray from the sun, applies to the generation and development of living tissue or the living cell was discussed.

The series of classes which for the past two years has been open to the public has drawn a considerable amount of attention not only from local people but throughout the United States, letters of inquiry being received by Dr. Hannen from educational and science leaders all over the country.

The classes drew an audience of 30 throughout the school year, beginning in early fall and continuing on through until three weeks before school closed in the spring.

The Johns Hopkins University. Dedication of the Francis P. Garvan Chair of Chemical Education and a Conference on the Selection and Training of the Superior Chemistry Student—Friday, October 11, 1929.

11 A.M. Dedication of the Francis P. Garvan Chair of Chemical Education: PRESIDENT JOSEPH S. AMES.

Response: FRANCIS P. GARVAN, President of the Chemical Foundation, New York.

Addresses: "The Education of the Superior Student," DR. JOHN J. ABLE and DR. IRVING LANGMUIR.

1 P.M. Luncheon.

3 P.M. Conference on "The Selection and Training of the Superior Chemistry Student."

6 P.M. Dinner.

8 P.M. Address: "The Production of a Photographic Image," DR. C. E. K. MEES, Director of Research, Eastman Kodak Company.

Cyanide Poisoning from Polish on Hotel Silver. The shiny, freshly polished spoon or fork may not be the best one to pick out in a cafeteria or hotel dining room, it now appears. A number of cases of acute cyanide poisoning have been traced to polish used on table silver and other metal kitchen or eating utensils in various hotels in New York State, the State Department of Health has recently reported. No deaths have been reported so far, but a number of persons have been made seriously ill.

When several cases of illness, apparently food poisoning, were reported occurring in persons who had dined at an upstate hotel, health officers began investigation, following every clue that might lead to discovery of the guilty substance that had caused the illness, whether food or germ. They found that the hotel's silver had just been polished. Chemical analysis of the silver polish used showed that about one-fifth of it was composed of poisonous sodium cyanide. Further investigations disclosed that other hotels and restaurants in the state and in New York City were using this or another cyanide-containing polish for their silver. This fact probably accounts for numerous unexplained cases of severe illness following meals in hotels and restaurants.

One woman, whose work entails considerable traveling, reported having suffered twelve different attacks during a year while stopping at hotels in various cities. Some hotels have already reported that attacks of similar illness among their guests have ceased to occur since this type of silver polish has been discarded.

The Health Department is continuing studies to determine the extent of the use of cyanide compounds in the polishing of cooking and eating utensils in public eating places throughout the state.—*Science Service*

Recent Books

Home among the Atoms. (A First Volume of Candid Chemistry.) JAMES KENDALL, A.M., Sc.D., F.R.S., Professor of Chemistry and Dean of the Graduate School, New York University; Professor-Elect of Chemistry, University of Edinburgh. The Century Co., 1929. xvi + 318 pp. 21 illustrations. 13 × 20 cm. $3.00.

Coincident with the coming of the so-alled "Chemical Age" in our present dustrial and economic life, there has isen a desire on the part of the non-ientific reading public to know more the facts of science, and particularly ose of chemistry. As a result of this mand numerous attempts have been ade and are being made to popularize r science. Syndicate writers and others limited knowledge of science have fortunately been prone to exaggerate e facts in order to create a sensation. veral splendid popular treatises on hemistry have, however, been published America, especially those of Slosson d Howe, and they have done much advance popular interest in chemistry. hese writers have, however, confined emselves chiefly to descriptive books the chemistry and manufacture of aterials in every-day use. Comes now rofessor Kendall with an attempt to t forth the fundamental principles upon hich the science of chemistry rests, d the reasoning by which the chemist as been able to make his remarkable scoveries. Few writers are gifted to vest the stern, abstruse facts and rinciples of science of their technical rminology, and put them into language hich the layman can understand. This ppears to be especially true of scien-ific men who think and speak in tech-ical terms, and whose language is foreign nd unintelligible to the layman. The reader of this book, "At Home among the Atoms," will promptly agree that the author has achieved his difficult aim in phenomenal measure.

The book constitutes a romantic journey through the scenic wonders of chemical science. One by one, the writer introduces his reader to the entire gamut of classic milestones in the history of chemistry: atomic weights, valence, chemical equations, energy in relation to matter, radioactivity, isotopes, atomic and molecular theory—in a delightfully entertaining conversational style, vivid in description, and sparkling with rich humor. There are twenty-two chapters, the thirteenth being omitted to avoid "injuring the feelings (of the elements) by herding them together under the handicap of a so-called lucky number!" The periodic system of the elements is likened to an eight-story apartment house, called Mendeléeff Court, the elements of the successive vertical groups in Mendeléeff's Classification being represented as the occupants of the respective floors of the court. The important relationships and properties of the common elements are here brought out, together with their numerous commercial applications. The work of Moseley, Aston, Bragg, Rutherford, Lewis, Harkins, Curie, Bohr, Schrödinger, and others, difficult as much of it is to state in simple terms, is set forth with remarkable clarity and sequence. The concept of atomic number and its relation to the structure of the atom is shown to lead to a new classification of the elements, which the author chooses facetiously to call "Bohrville," a city of seven avenues corresponding to the successive short and long periods of elements, and named "in honor of the man who has done much to promote

its settlement!" Throughout the entire presentation one is impressed with the assiduity displayed by the author in sticking to the facts as established by experiment.

In order to gain and hold the attention of his reader, the author freely personifies the electrons, atoms, and molecules under discussion and employs some of the common human relationships to draw his analogies and drive home the idea he wishes to convey. "The desire of the sodium atom to lose an electron" (p. 179); "copper would be happier with mercury than with gold (p. 258); "each atom of zinc has donated to each copper ion two electrons as heartbalm for the alienation of sulfate ion's affections" (p. 183); "companionate or group marriage between Na+ and Cl−," and "a feeling of resentment rankling in the breast of hydrogen," are some of the striking examples. Whether we approve of such procedure or not, the author certainly appears justified in employing it in an instance such as this where the processes under discussion are invisible to the eye and can be made intelligible only through the medium of commonplace illustration.

The book is illustrated with a number of well-chosen figures and with photographs of some of the world's greatest scientists. Tables of data often bewilder the layman, and only two or three are used in the entire book. It is well printed and strikingly free from typographical errors. The book should be on the shelves of every library in this country. It will inspire many a student to enter chemistry as a profession. High-school teachers, advanced college students, and even university professors can well read the book, not only for the splendid manner in which the historical background of chemistry is delineated, but also for the numerous suggestions for elucidating intricate points. The author is to be commended upon this excellent piece of work. T. F. BUEHRER

UNIVERSITY OF ARIZONA
TUCSON, ARIZONA

A Concise Summary of Elementary Organic Chemistry. FREDERICK HURN CONSTABLE, M.A., D.Sc. (London), Ph.D. (Cambridge), F.I.C., Fellow of St. John's College, Cambridge. First edition. E. P. Dutton and Co., Inc., New York, 1929. xii + 146 pp. 13 × 20 cm. $2.00.

The purpose of the book, as stated in the preface, is to provide a quick method for surveying the elements of the subject. It is offered more specifically by the author to students who wish to prepare themselves for certain examinations at the English universities.

It is, then, a glorified syllabus for a first-year course in organic chemistry and it seems to have been done very completely and efficiently. The reactions, properties, preparation methods, etc., of the commoner and more important classes of compounds are listed briefly under the proper headings. To quote the author: "The general plan has been followed, whenever possible, of first giving a list of reactions common to a class of compounds, and then studying some particular examples, a plan which shows clearly such relations between members of a homologous series as are characteristic of the subject."

Used in conjunction with a good text, or better, at the end of a course of lectures and reading, the book should be an aid to the student in organizing his knowledge and getting it into more systematic form than usually results from reliance on memory or a lecture notebook. There is, however, a certain danger of placing such a summary in the hands of a group of students. It is the danger attendant on the improper use of any syllabus or outline: a superficial knowledge hastily acquired for the purpose of securing a pass mark in an examination and then immediately forgotten. GREGG DOUGHERTY

PRINCETON UNIVERSITY
PRINCETON, N. J.

An Introduction to the Chemistry of Plant Products. PAUL HAAS, D.Sc.,

Ph.D., Reader in Plant Chemistry in the University of London, University College, and T. G. HILL, D.Sc., A.R.C.S., Reader in Vegetable Physiology in the University of London, University College. Volume II, Metabolic Processes, second edition. Longmans, Green and Company, 55 Fifth Ave., New York City, 1929. viii + 220, 12 figures. 21.5 × 14 cm. $3.75.

The authors' point of view is probably to be found in part of the statement for Volume I, since no similar statement occurs: ". . . . primarily intended for students reading for an honours degree in botany." The subject matter is restricted by the announcement: "In this volume the authors are concerned with the most significant metabolic activities of the plant; the synthesis of the carbohydrates, fats, and proteins; respiratory processes; and, finally, growth. The increase in knowledge and the trend of current thought on these matters have necessitated a great deal of revision, with the result that the work has for the most part been rewritten."

The intention to teach botany students chemistry may be traced through the book; thus morphological and cytological relationships are not discussed. This is not altogether objectionable in a text on plant chemistry for chemistry majors, because it does not attempt either to teach botany or to deal with it in such a way as to require an intimate knowledge of it. Like Volume I, it is written for reading rather than for reference, and would probably serve best as a collateral text for chemistry students. The authors disclaim the intention to furnish a guide to the literature, hence there is no bibliography. References are numerous, but they occur as footnotes, keyed to the text by symbols; a system that must seem cumbersome to those familiar with unified bibliographies. On the whole the book is composed with scholarship and care, and should be welcome in the field for which it is intended.

This volume deserves consideration as collateral reading by teachers of chemistry separately from Volume I. References to the first volume are not frequent, and little harm is done if they are not looked up. Volume II presents fundamental plant processes, while Volume I contains many details not essential and perhaps not even important for all plants. Thus, Volume II possesses favorable aspects as a chemistry student's introduction to plant chemistry.

Those familiar with the earlier edition will find this one more than half again as large, although not much thicker, due to the use of more highly calendared paper. If anything, the presswork and readability is improved, and the binding and format are very little different. The original text has been reset where used, but more than half of it is intact by whole paragraphs, the changes being, for the most part, the shifting about of paragraphs and sections, and the insertion of new material to bring the book up to date. Citations from publications of 1928 are found in nearly every section. For this reason, although the authors have striven to avoid a partisan attitude and have ventured into controversial fields with caution, some ideas will have been included that they will later abandon. For example, in this edition no mention is made of the formhydroxamic acid theory of Baly in the treatment of the synthesis of nitrogen compounds, while the views of Maquenne on carbohydrate synthesis receive considerable attention.

E. L. GREEN

THE STATE COLLEGE OF WASHINGTON
PULLMAN, WASHINGTON

Medical Education, 1926–28. N. P. COLWELL, M.D., Secretary of the Council on Medical Education and Hospitals of the American Medical Association. Department of the Interior, Bureau of Education, Bulletin No. 10. Govt. Printing Office, Washington, D. C. 1929. 14 pp. 14.5 × 23 cm. $0.05.

Contents—Medical students; medical

graduates; ages of graduates, class of 1928; medical students who did not graduate; negro medical students; enlargement of medical-school plants; saving time in medical education; relative supply of physicians in the United States; supply of physicians in the various states; medical school finances, 1926–27; graduate medical education, experiments in medical teaching, hospital interneship, specialization; investigation regarding medical education; investigation regarding the cost of medical care.

Smith's College Chemistry. JAMES KENDALL, F.R.S., Professor of Chemistry in the University of Edinburgh; formerly Professor of Chemistry at Columbia University and at New York University. The Century Co., New York City. Revised edition, 1929. xii + 759 pp. 16 full-page photographs, 178 diagrams. 14 × 21 cm. $3.75.

The book has not been enlarged over the size of the well-known 1923 edition but there are three main changes. They are, in the words of the author: "(1) the re-arrangement of the sections dealing with atomic and molecular weights; (2) the introduction of new ideas on the ionization of strong electrolytes; and (3) the advancement of the chapter on atomic structure."

The early introduction of the chapter on the atomic theory and its development by discussion of the rôle of separate atoms in crystal structure is new and should give the student a clearer picture of the atom than he usually has in the early part of his course. These fundamental concepts have in many texts been isolated in one chapter, which seems to be more of an addition rather than an integral part in the logical development of the subject. The chapter on atomic structure, placed in the middle of the book, has twenty-three pages. It is so condensed that the student will probably need supplementary readings and a thorough classroom discussion to gain a clear understanding of the topic. The inclusion of the recent theories of ionization is excellent.

It is the opinion of the writer that the portion of the text devoted to the metals, about one-fourth, is rather brief. Some of the so-called "rare metals," such as tungsten, are no longer rare in their many uses and deserve more attention than is given.

In the revision of "Smith's College Chemistry" Professor Kendall has maintained the high standard of excellence evident in all the series and presents a teachable text. An interesting feature is the inclusion of sixteen full-page reproductions of photographs of historical and technical interest, which are fully described in the introduction. The type is clear and the general physical make-up of the book is good.

L. F. YNTEMA
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

A Laboratory Outline of Smith's College Chemistry. JAMES KENDALL, F.R.S., Professor of Chemistry in the University of Edinburgh; formerly Professor of Chemistry at Columbia University and at New York University. The Century Co., New York City. Revised edition, 1929. vi + 198 pp. 14 × 21 cm. $1.50.

This is a manual designed to furnish laboratory work to accompany the text reviewed above. It contains a wide variety of experiments, more than can be performed in a year, and thus offers choice in the assignment of work. Alternate pages are blank.

L. F. YNTEMA
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

A Brief Course in Chemistry. LYMAN C. NEWELL, Professor of Chemistry, Boston University. D. C. Heath and Company, Boston, 1929. vi + 412 pp. 233 figures. 12.5 × 18.5 cm. $1.48.

The subject matter of the book is limited to the topics for a minimum course in chemistry. It consists of two parts.

rt I (254 pages, 146 illustrations) in-ides the basal topics selected by the mmittee of the A. C. S. as essential for a ief course in chemistry. *Part II* in-ides supplementary topics suitable for ditional study in special fields and for veloping a course adapted to local needs. he topics in both parts are connected by oss references and at the end of most hapters in *Part I* there are references by umber and title to supplementary sec-ons in *Part II*.

The exercises and problems at the end of ch chapter are chosen to drive home cts and principles not readily learned in her ways. Laboratory work is corre-ted by suggestions, at the end of each hapter, to experiments needed for the ief course. These references are to the uthor's "Laboratory Exercises for a rief Course in Chemistry."

The illustrations, including many photo-raphs, are particularly interesting. Pos-ibly one cannot agree with the author hen, in his discussion of iron compounds, e states that "reduction is the loss of a ositive charge." However, oxidation nd reduction are later discussed in terms f electrons.

Teachers desiring to follow the recom-endations of the A. C. S. committee ill find that this book will suit their eeds.

E. G. VANDEN BOSCHE

UNIVERSITY OF MARYLAND
BALTIMORE, MD.

olumetric Analysis. I. M. KOLTHOFF, Professor of Analytical Chemistry at the University of Minnesota, with the collaboration of DR. ING. H. MENZEL, Dresden. Translated by N. HOWELL FURMAN, Ph.D., Associate Professor of Analytical Chemistry, Princeton University. Vol. II., Practical Volumetric Analysis. John Wiley and Sons, Inc. New York, 1929. xiv + 552 pp. 18 figures. 15 × 23.5 cm. $5.00.

In the preface of his book, the author states that it was written to fill the need for an up-to-date, critical, comprehensive work on volumetric analysis. It is not intended as an encyclopedia of analytical methods; instead Dr. Kolthoff has chosen to give only those methods which have practical significance and have been proved reliable. The author claims to have personally tested the majority of the methods presented and, in general, chemists will agree with his selection. The literature has been scanned carefully and the book is replete with references.

Practical Volumetric Analysis is evidently not intended for beginning students in quantitative analysis. The discussion is not detailed enough and a knowledge greater than that of the average first- or second-year chemistry student is required to follow the discussion. It also would probably not appeal to the practical analyst who is looking for a set of directions for a particular determination. The methods of analysis given are for salts and fairly pure substances. The decomposition of ores and other heterogeneous materials is not considered. The book will prove of value to the more advanced student of analytical chemistry and to the chemist who desires a compendium of the generally accepted methods.

Parts of the book which deserve commendation are: the exceptionally fine section on the choice of indicators and the preparation of their solutions; the discussion of standardizations and the selection and purification of the primary standards; the inclusion of data on equilibrium constants and solubility products.

The divisions of volumetric analysis and the same order used in Volume I are followed in Volume II. The use of potassium bromate, potassium iodate, titanous chloride, and ceric sulfate as titrating agents is included as is also the volumetric analysis of some organic substances. About fifty pages of the newer material have been contributed by Dr. Furman.

The translator has been faithful to the original text and the translation has been well done. The book is nearly

free from misprints. The following changes are suggested for future editions of the book. The table of specific gravities and normalities, page 72, would be more adaptable to American practice if the data were given for 25°C. instead of 15°C. The latest international table of atomic weights should be used to avoid confusion. It would be better in several instances if the amounts of substances used in reactions were stated more definitely, *i. e.*, the directions "add a little water" or "add an excess" might be interpreted differently by different analysts. On page vi, line 22, *three* should read *there*. The second paragraph on page 46 is a bit ambiguous and would be clearer if not translated quite so literally.

L. C. CADY

UNIVERSITY OF IDAHO
MOSCOW, IDAHO

Magnetism and Electricity. MORRIS MEISTER, New York Training School for Teachers, College of the City of New York, and Editor, *The Science Classroom*. Charles Scribner's Sons, New York City, 1929. xiv + 210 pp. 149 illustrations. 13 × 19 cm. $1.00.

This book is the third of a series of four texts, "Living in a World of Science," which endeavors to "humanize the scientific facts, principles, and conceptions of the world in which we live." It is intended to present some of the principles of magnetism and electricity in a form understandable for pupils of the seventh and eighth grades.

The subject matter is divided into sixteen chapters on "a chapter a week" plan. Each is concluded with a "true-false," or similar test, "How Much Do I Remember?" and a list of "Things to Think About and Find Out About." Wherever suitable, suggestions have been inserted of "Things to Make and Do." The appendix contains an extensive bibliography suitable for reference and corollary reading, and an extended discussion on "How to Organize and Conduct a Science Club." The text is profusely illustrated with practical, familiar, and homely examples of the applications of magnetic and electrical principles to everyday experience and to commerce.

Each chapter deals either with a general topic, such as magnetic induction, electric heating, radio reception, or with commercial appliances, as electromagnet, dynamo, vacuum tube. Statements of underlying principles are given as facts, with an absolute minimum of theoretical discussion, accompanied by historical data and numerous interesting examples of practical application.

The text is written in a style that should appeal to the students for which it is intended, very informal, clear, readable. In order to develop and maintain interest the book is interspersed with anecdotes, newspaper clippings, and stories from the lives of eminent scientists.

This text should serve admirably for the purpose of giving young students an elementary introduction to the phenomena of magnetism and electricity, and to create an interest in their further study. The text belongs in that category of books which tend to popularize science.

CHAS. G. EICHLIN

UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

Students' Potentiometer. *Bulletin* No. 765. Leeds & Northrup Co., Philadelphia, Penna., 1929. 20 pp. 20 × 26.5 cm. Diagrams. Free.

In this *Bulletin* the features of the instrument which adapt it to student use are pointed out. In addition, numerous applications of the potentiometer are described and the potentiometer principle is clearly explained.

Notes on the Kelvin Bridge. *Note Book* 4. Leeds & Northrup Co., Philadelphia, Penna., 1929. 36 pp. 13.5 × 20 cm. Diagrams. Free.

In this pamphlet the purpose and theory of the Kelvin bridge as well as numerous adaptations of it are discussed.